A SURVEY OF POLYCHLORINATED BIPHENYLS IN AMBIENT AIR IN ONTARIO

PHASE III

Detection and Determination of Polychlorinated Biphenyls in Ambient Air Samples by High Resolution Gas Chromatography and the 1980 Survey

Report Number ARB-26-81-ARSP

July, 1981

Ministry of the Environment
Ontario

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Air Resources Branch
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FOREWORD

This report is part of a series of reports published by the Ministry of the Environment, Air Resources Branch - on the development of techniques for collection, detection and determination of Polychlorinated Biphenyls in ambient air and results of surveys performed in Ontario in the periods of Sept.-October 1979 and June 1980. The reports of this series are:

ARB-TDA-08-80-Phase I	-	Development of Laboratory and Field Procedures
ARB-011-81-ARSP-Phase II	-	Volume I; Sampling Site Selection and Analytical Procedures.
ARB-025-81-ARSP-Phase II	-	Volume II; Meteorological Correlation for the 1979 Survey of Polychlorinated Biphenyls in Air in Ontario.
ARB-026-81-ARSP-Phase III	-	1980 Survey of Polychlorinated Biphenyls in Air in Ontario.

This series of reports should be considered as a unit, and the individual members of the series should be evaluated in concert with the other members. This situation arises since this work was developmental in nature and the reports present a chronological picture of the work done, over a period of time, on the sampling, sample processing and analytical procedures. The Phase III Report describes the current state-of-the-art for PCB sampling and analysis as developed by MOE scientists.

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SUMMARY

A new method - high resolution gas chromatography with two columns of different polarity - was developed for the analysis of environmental samples for Polychlorinated Biphenyls (PCB's). It is estimated that the new method increases the confidence in the analytical data from 60 to 70% for a single column to 80 to 90% for the dual column high resolution gas chromatography $(GC^2)^2$.

A method of the identification of individual PCB congenors based on the retention indices was developed, as well as a method for the quantification of PCB congenors where no standards are available.

A set of rules for the reduction of data from 2 columns of different polarity was established. As well, a program was developed for the microprocessor controlled HP 5880A GC. The program controls the HP Autosampler 7672A, initiates the recalibration, performs the data reduction and stores all data on magnetic tape.

A set of samples from the 1979 PCB ambient air survey across the Province of Ontario was reanalysed by the new technique and the results are reported.

A survey of PCB's in the ambient air across the Province of Ontario was performed in June, 1980. The processed samples were analyzed by the new technique and the results are reported.

The new analytical technique indicates that the 24-hour average background ambient air concentrations of total PCB's across the Province of Ontario are less than 1 ng/m^3.

INTRODUCTION

During the previous work on monitoring and detection of PCB's in ambient air (1, 2, 3, 4, 5, 6), the limitations of the widely used gas-chromatographic methods with packed columns and quantification based on the characteristic fingerprints of commercial "Aroclors" were soon realized. These methods (7, 8, 9) assumed that:

a) The ratio of individual PCB's in the vapour phase was identical or at least very close to the ratio in the liquid phase.

b) The ratio of the PCB's did not change after exposure to biological or ambient environment.

c) All interfering compounds could be removed from the sample during the clean-up procedure and, if any stayed in the processed sample, they were resolved and, thus, the PCB peaks could be identified and quantified with high degree of confidence.

d) If the fingerprint resembled a mixture of two or more commercial "Aroclors" in an unknown ratio, a new standard could be easily synthetized (by mixing commercial "Aroclors") to match the fingerprint and enable quantification.

However, the distribution patterns of PCB's in ambient air can be altered because of the differences in volatilities, solubilities, and chemical and physico-chemical reactivities of the individual components of the original mixture. The fingerprint of a commercial "Aroclor" may also change after exposure to the environment (10, 11). The fact that PCB's may be photolytically degradated has been shown (12, 13). During the previous work on PCB's in air, it was rare to find samples where the fingerprint resembled the fingerprint of a commercial "Aroclor" mixture, unless the sample was collected close to a known source and the concentrations of PCB's were significantly higher than the concentrations usually encountered in ambient air.

The efficiency of the clean-up procedures of ambient air samples have been questioned as well. It has been estimated that in the concentration range of PCB's in ambient "clean" air, at least 10^5 organic compounds can be expected to be present (14). Only a fraction of these low level impurities have been identified and it was a reasonable assumption that a significant number may not be removed by the clean-up procedure. Some may have retention times close to the retention times of the PCB's and also may be detected by the EC detector.

PCB analysis is further complicated by the fact that not a single or small number of species are involved. There are 209 possible congenors of PCB's; 102 of which have been identified in commercial "Aroclors", and are likely to be encountered in environmental samples (15, 16, 17).

Most analytical methods to date accomplish identification and quantification by comparison of the total peak area or height of all matching peaks in the sample with the peaks of commercial "Aroclors" (8, 9). For most ambient air samples, the source of contamination is usually unknown and any similarity to a commercial "Aroclor" is likely to be purely fortuitous.

The problem of identification and accuracy in PCB analysis is not easily solved. Because of the complexity of commercial mixtures, identification of individual congenors was not practical until recently. One possible solution to the problem was to convert all of the PCB components to one entity by perchlorination (18). The total PCB content was then measured as dekachlorobiphenyl. Analytical methodology for this technique, however, has not been established and accepted.

Until recently, high resolution gas chromatography, GC^2, was limited to research and development laboratories only. However, in the last few years, coated glass-capillary columns of good quality have become commercially available along with instruments designed for work with capillary columns. The advent of fused silica capillary columns together with microprocessor controlled gas-chromatographs made the use of GC^2 even more attractive. Almost at the same time, a number of individual PCB's have been synthesized and the GC^2 has been slowly introduced into routine PCB analysis. The advantages are obvious,

a) High resolution power of capillary columns as compared to packed columns enables better resolution of the majority of individual PCB's from each other and from impurities.

b) Because of the high resolution power of GC^2 and commercial availability of many individual PCB's, the possibility of identifying and quantifying PCB's is improved. PCB's may be identified and quantified with a higher degree of confidence, even when the fingerprint does not match a commercial Aroclor at all.

However some questions were not resolved at the time the analysis of the 1979 survey (19, 20, 21) were performed. These were:

a) not all the individual PCB's, as they were identified and present in commercial "Aroclors", were commercially available.

b) not even the GC^2 was able to resolve all individual PCB's.

c) there still remained the possibility that some impurities, present in ambient air sample and not removed by the clean-up procedure, may be identified as PCB's because of the close retention times under the conditions used.

Between our 1979 and 1980 surveys, a new gas chromatograph with a more powerful microprocessor became available - the HP 5880A - and further work on the refinement of the detection and determination of PCB's was performed, which has increased the confidence in the ambient air data.

EXPERIMENTAL

GAS CHROMATOGRAPH AND AUXILIARY EQUIPMENT:

Hewlett-Packard Model 5880A gas chromatograph with capillary injection port (split and splitless), dual flame ionization detector and dual Ni^{63} Electron Capture detector, level IV "Basic" microprocessor, two terminals and Hewlett-Packard Model 7672A automatic sample injection system.

COLUMNS:

Hewlett-Packard fused silica capillary columns as specified in Table 1.

CHEMICALS:

All solvents were pesticide grade. The pure PCB congenors were obtained from the RFR Corp., Rhode Island, U.S.A.

Aroclor standards were obtained from three sources

a) Food and Drug Administration (U.S.A.): 1016 (#1151-77029); 1242 (#399-71696); 1248 (#398-71697); 1254 (#370-71698); 1260 (#371-71699)

b) Environmental Protection Agency (U.S.A.): 1016 (#9324); 1221 (#9382); 1232 (#9307); 1242 (#9534); 1248 (#9308); 1254 (#9533); 1260 (#9413); 1262 (#9241)

c) Monsanto: 1221 and 1232 (no batch number)

PROCEDURE:

Two fused silica capillary columns were connected via a graphite ferrule to the single injection port and each to its own Electron Capture detector.

All GC-analyses were temperature programmed to permit analyses to be done in reasonable length of time with adequate resolution of the PCB congenors, good reproducibility and for ease of Kovats retention indices calculation for each congenor on each phase. The GC-conditions used with the investigated columns are listed below:

COLUMN PAIR: SP-2100/Carbowax 20M (DSC 1); OV-1/SE-54 (DCS 2)

INJECTOR TEMPERATURE: 300° C

DETECTOR TEMPERATURE: 300°C

CARRIER GAS - HELIUM: Column head pressure 180 kPa

MAKE-UP GAS - NITROGEN: 30 ml/min

INJECTION: Splitless, 1 ul, injected by the HP-autosampler, valve closed for 30 sec., alternate vials filled with clean solvent (iso-octane) to wash the syringe immediately after injection.

TEMPERATURE PROGRAMMING: 70°C, hold for 1 min. Then temperature programme rate 10°C/min to 130°C, then temperature programme rate 3°C/min to 220°C and hold for 13 min.

AMBIENT AIR SAMPLING:

The ambient air sampling procedures, equipment and location of the sampling sites were identical to the 1979 Ontario-wide PCB survey (20, 21, 22).

SAMPLE PROCESSING:

All collected samples were processed in an identical way as to that already described elsewhere (19).

RESULTS AND DISCUSSION

Sisson and Welti (23) reported that the retention indices (RI_s) for PCB's could be calculated by summing up the ½RI values for the two substituted rings. In this study we extended the retention idex calculations for PCB's to the high resolution fused silica capillary column under temperature programmed conditions. Said and Hussein (24) have developed a formula for the determination of Kovats retention indices for temperature programmed chromatography. The version of their equation applied to the data is

$$RI = 100 \cdot \left[C_{N-1} + (C_N - C_{N-1}) \frac{T_N - S_{N-1}}{S_N - S_{N-1}} \right] \quad (1)$$

where S_N and S_{N-1} are the retention times of two n-parafinic hydrocarbons with the carbon number C_N and C_{N-1} which bracket in the compound with the unknown RI and retention time T_N.

The Kovats retention index system is used to describe the behaviour of a compound as equivalent to that of a hypothetical n-parafinic hydrocarbon. For the four phases listed in Table 1, the n-alkanes C_{12} to C_{36} were used as the reference points for the calculation of the retention indices. The ½RI's were determined either by taking one half of the retention index of a symetrically chlorinated biphenyl, or by subtracting the ½RI of biphenyl from the retention index of a chlorinated biphenyl, having only one ring substituted (symmetric or asymmetric parents respectively). Table 2 presents the ½RI values for the four phases.

DUAL COLUMN TECHNIQUES AND ANALYSIS METHODS

The simultaneous gas chromatographic analysis on two capillary columns $(GC^2)^2$ is difficult with glass capillary columns. Any attempt to seal two glass columns in one injection port would surely fracture them and the use of a splitter may create dead volume and sealing problems. The development of fused silica capillary columns with the combined benefits of flexibility, inertness, excellent thermal stability and high efficiency eliminated the difficulties previously associated with capillary chromatography. A protective coating of polyimide on

the outside of the column prevents loss of strength during handling and use. The fused silica capillary columns are inherently straight, permitting direct insertion into the injection port and detector fittings. The above advantages allow the physical insertion of two fused silica capillary columns into a single capillary injection port. A graphite ferrule is used to seal the columns.

For the analysis one microlitre of liquid sample was injected into the injection port in splitless mode. Because the columns were of the same length and internal diameter (25m, 0.2 mm) it was assumed that the sample splits equally between both columns. Calibration took into account any variation in the sample split ratio. The column outputs were inserted into either the dual FI or dual EC detectors and sealed with graphite ferrules.

All the available PCB congenors were run individually on each liquid phase so the retention times and the elution order could be determined. Table 3 contains the order of elution of the available PCB's congenors for each phase. In order to calculate RI for the known PCB's and to be able to generate the RI's of the unavailable PCB's, a set of calibration solutions was prepared to reduce the time interval between g-c runs of the alkanes and all the PCB solutions in order to minimize the effects of any gas chromatographic changes on the RI calculations. Table 4 contains the distribution of the known PCB's in the five solutions used for the liquid phase calibration.

The solutions were chromatographed in the following sequence:

1. Linear gas velocity and gas hold-up volume measurements were performed with ethane at oven temperatures of 70 and 200^{o}C and FI detectors.

2. A solution containing n-alkanes C-12 to C-26 inclusive plus C-28, C-30, C-32 and C-36 was run. A solution of biphenyl was the subsequent run. As a reproducibility check, the above solutions were rerun.

3. The columns and the makeup gas assemblies were removed from the FI detectors and inserted into the EC detectors. The following order of solutions was run
   a) 2,2-bis-(p-chlorophenyl)-1,1-dichloroethylene (pp'-DDE) + 1234-tetrachlorobenzene (1234-TCB);

b) PCB solutions A to E;

c) pp'-DDE + 1234-TCB;

d) Aroclors 1016 to 1260;

e) pp'-DDE + 1234-TCB.

The whole series was repeated as a check.

4. The columns and the makeup gas assemblies were inserted into the FI detectors. Section 2 was repeated. This allowed a check on liquid phase stability over the time period of the calibration.

The data obtained for each column are listed in Tables 5 and 6.

The ½RI values calculated from Table 6 are listed in Table 2.

DCS-1(SP-2100/CARBOWAX 20M).

Initially the only two liquid phases available on fused silica capillary columns were SP-2100 and Carbowax 20M. Neither phase was ideal for the dual column analyses of PCB's but at the time there was no choice. The only advantage was that the two phases were quite dissimilar; SP-2100, the non-polar phase and Carbowax 20M, the polar phase. Separation of the available PCB congenors on each phase yielded quite different elution patterns (see Table 3). The confirmation of a PCB on both phases would provide a very high confidence for its existence.

A number of disadvantages were found with the DCS-1 system. The temperature limit of the Carbowax 20M phase (220^{o}C) was too low to allow for all the PCB congenors to be temperature programmed through the column. The PCB congenors of the calibration solutions that eluted from the Carbowax 20M column exhibited a steady decrease in retention times, the column exhibited loss of resolution of closely spaced components and significant peak tailing. The use of the Carbowax 20M liquid phase to its temperature limit for each dual column G.C. run lead to a rapid deterioration of the column resulting in a significant decrease in the column's useful lifetime. As a consequence, system calibrations had to be run with greater frequency as the retention times and the response factors of the PCB's fluctuated significantly.

For the SP-2100 phase the retention times were highly reproducible and stable over long periods of time as long as the conditioning temperature did not exceed 240°C and 220°C during regular use under temperature programming. Peak tailing and loss of resolution did not become appreciable until at least 1000 samples had been analysed.

The higher boiling PCB's have to be temperature programmed through the column in order to simplify the retention index calculations for the SP-2100 and Carbowax 20M liquid phases. As this was not possible for either column in the DCS-1 system, the data obtained for each phase characterization was used as is. For SP-2100 the results were good and a definite set of rules could be established to predict the retention index for unavailable PCB's (Table 7). In the case of the Carbowax 20M liquid phase, a large fluctuation in the calculated RI values for available PCB's not used in the initial ½RI calculations (Table 8) undermined the confidence to predict accurate RI values for the PCB's.

The subsequent availability of two new phases on fused silica capillary columns prompted the abandonment of the SP-2100/Carbowax 20M dual column system.

DCS-2 (OV-1/SE-54)

Prototype fused silica capillary columns containing the gum phases OV-1 and SE-54 were obtained from Hewlett-Packard, Avondale, U.S.A. Both of the gum phases were derived from the SP-2100 liquid phase with the major improvement being the temperature limit of 350°C. The OV-1 phase is almost identical in polarity to the SP-2100 phase while the SE-54 phase is slightly more polar. As described for DCS-1, the two columns were inserted into one injection port and the column outputs were attached to separate detectors. The available PCB congenors were run individually through the two columns and the resulting elution orders are listed in Table 3.

The high temperature stability of the OV-1 and SE-54 phases allowed all the PCB congenors to be temperature programmed through the column and to be used in the RI calculations. The column calibration solutions described in DCS-1 were run in the identical manner for DCS-2. The results of the n-alkanes and known PCB solutions (A to E) are presented in Tables 5 and 6, respectively.

Equation (1) was used to calculate the retention indices of the known PCB's (Table 6). The ½RI values for the various PCB fragments are given in Table 2. They were used to generate the RI values for as many unknown PCBs as was possible. A set of rules to select the proper parent fragments was developed to simplify RI identification procedure. Table 7 outlines the rules and the exceptions as deduced from the PCB congenors listed in Table 6. These rules were applied to the "Aroclor" samples chromatographed in the column calibration time frame. A Hewlett-Packard 9830A computer system utilized "Basic" computer programs to calculate the RI values for all the PCB peaks and to search the calculated and known PCB RI's for matches to the RI value of each "Aroclor" peak. The rules for OV-1 and SE-54 liquid phases (Table 7) were manually used to screen the PCB congenor possibilities for each "Aroclor" peak. The final results for each "Aroclor" for the OV-1 and SE-54 phases are presented in Tables 10 and 11.

Not all the "Aroclor" peaks could be identified as not all the possible PCB parent fragments could be derived from the available PCB congenors (see Table 2).

CALIBRATION STANDARD DEVELOPMENT

Initially the DCS-2 system was used in the relative retention time (RRT) mode to pinpoint the elution locations of the PCB congenors. A standard solution composed of 52 known PCB congenors was run through the dual column system and was used to calibrate each channel. All PCB samples which were examined were spiked with pp'-DDE and 1234-TCB as internal reference standards to correct for any changes in the retention time. The pp'-DDE peak was also used as the reference peak for the calculation of the relative retention times. The available "Aroclor" mixtures were analysed against the standard solution. Relative retention times (RRT) of all the peaks were printed out. The response factors of the major "Aroclor" peaks were calculated by averaging the response factors of the known PCB's bracketing the unknown peak, as determined from the calibration. Table 12 presents the RRT data, average response factors and "Aroclor" source for all the major PCB peaks in the commercial "Aroclors". For each unidentified peak in an ambient air sample extract, a manual RRT matching and amount calculation was performed. The total amount for the

"Aroclor" PCB contribution was obtained per phase and these two values were averaged to give the "effective" contribution from unidentified "Aroclor" peaks. The sample peaks that matched the calibration standard on each column were microprocessor analysed. The total PCB contribution from PCB peaks that were matched on both columns were printed out. The subsequent total of the unidentified "Aroclor" peak contribution and the calibration match value would give the total PCB concentration (ng/m^3) for the ambient air sample extract. This method was used to analyse the samples collected at Isabella Public School in Thunder Bay (25) and at D & D Disposal site in Smithville (26), however, it was not only very labour intensive but it may not have improved significantly on the confidence of the analysis as compared to the single column high resolution chromatography. It was used only because the new quantification methodique was not yet proven and during the two above mentioned surveys, the samples were collected close to a known source of PCB's. The PCB concentrations were significantly above the background level and the fingerprints resembled some commercial "Aroclors".

To take full advantage of the dual column high resolution gas chromatography it was necessary to develop and prove:

1) A standard, which would contain in known amounts, all PCB congenors which may be found in ambient air samples;

2) A set of rules for the correlation of the gas chromatograms on two different capillary columns;

3) A programme for the microprocessor of the HP-5880A which would perform the data reduction of the recorded and tentatively identified PCB's from each column.

AROCLOR STANDARD

Increased confidence in the analytical results and simplification of the methodology was the main goal for this development. The HP5880A microprocessor is able to identify and quantify only the peaks for which the retention times and response factors are entered into the microprocessor's

memory. Only a limited number of individual PCB's are commercially available (we were unable to obtain additional PCB's from Prof. Safe, University of Guelph) and significant number of the availble congenors were not identified in commerical "Aroclors". It was therefore decided to synthetize a standard from commercial "Aroclors".

To be applicable to environmental samples such as ambient air, soil, water, surface swab, tissue and other extracts, as many identified and quantified PCB congenors as possible must be present in the standard. Three selected "Aroclors" (1016, 1221 and 1254) were combined into a single solution in the ratio 2:3:2 to cover the majority of the PCB congenors found in ambient air environmental sample extracts. The "Aroclor" mixture was analysed versus the 52 congenors standard calibration solution (Tables 13 and 14; Figures 1 and 2) to determine the amount of each known PCB isomer. The response factor and the amount for each peak not matched by the 52 isomer standard were calculated from the average response factor of the two neighbouring known PCB peaks and the unknown's peak area. An attempt was made to identify each of the unknown PCB peaks in the "Aroclor" standard through the use of the retention index calculations and the parent selection rules. Some identification difficulties were encountered when a number of peaks overlapped. Since the elution patterns from the two liquid phases were quite similar (Table 3), any discrepancies were resolved by identifying the peaks with the RI results that were the most consistent with all the "Aroclors". Figures 3 and 4 illustrate the g-c analysis of the new "Aroclor" standard on each column. Tables 13 and 14 list the respective calibration tables associated with the "Aroclor" standard for the OV-1 and SE-54 liquid phases. The entire g-c analysis, data comparision and report generation is undertaken by the HP5880A microprocessor. The final result of the report would be the total PCBs (ng/ml) found in the sample under investigation.

RULES FOR DATA CORRELATION

Before writing the program for the HP5880A microprocessor, rules for the data reduction were set down, under which the programme will handle and correlate the peaks, tentatively identified and quantified on each column as being PCB's. The rules are:

1) The retention time of the peak must be within narrow limits (usually $\pm$0.1%) of the expected retention time, otherwise the peak is rejected.

2) If the peak for a given PCB is identified on both columns and the quantities are within limits (usually $\pm$20%), the average is calculated and printed followed by the word "confirmed".

3) If the peak for a given PCB is identified on both columns, but the quantities are not within given limits, then the lower value is taken as the result, followed by word "interference" (it is assumed that the higher value is caused by an impurity coeluting with the PCB).

4) If the peak for a given PCB is identified on one column only, the value is rejected and identified by the words "not PCB".

5) Although the used capillary columns have very high resolving power some PCB's can not be resolved at all or can be resolved on one column only. If this happens, then the determined quantities of unresolved PCB's on one or both columns are summed up and evaluted under identical criteria.

PROGRAM FOR THE HP5880A GC

Following the aforementioned rules, a program was developed for the HP5880A GC microprocessor. The program not only automatically correlates the reports from both columns and prints out the final report, but it also:

1) controls the HP Autosampler Model 7672A;

2) recalibrates the GC after a preset number of samples with weight averaging of the retention times and response factors; and,

3) stores the reports on a magnetic tape for any later use.

The listing of the program is in Tables 18 and 19. Tables 20 and 21 are examples of the print out of the individual column analysis and in Table 22 is an example of the print out of the final analytical report. This example clearly

illustrates that even on a single capillary column interferences may be identified as PCB's (such as 3-mono on OV-1 or 2-mono on SE-54), however, the identification can not be confirmed on the second column. The sum of PCB's on OV-1 and SE-54 columns is 84.7 ng/ml and 40.5 ng/ml respectively, however, the data reduction program cuts down these values to 13.3 ng/ml only.

TESTING

The reproducibility of the method was tested by repeated analysis of a standard Aroclor mixture, containing 1117.2 ng/ml of total PCB's (Table 23). The recovery was 93.9% $\pm$3% of the expected value. However, Aroclor 1221 used to make the standard contains from 10 to 15% biphenyl depending on the batch. The contribution of biphenyl to the overall "Aroclor" standard mixture can therefore range from 4.3% to 6.4%. The addition of the biphenyl contribution to the overall PCB amount analysed indicates that the total is 98.2% to 100.3% of the expected total.

The Laboratory Services Branch of the M.O.E. provided a series of samples to test the PCB quantification methods. The results are presented in Table 24. The two quantification methods described in the report agreed quite well with each other and with the expected values. The spiking "Aroclors" were 1016 and 1254 for the B and A series, respectively.

Some of the samples of the 1979 Province-wide PCB survey were reanalysed with the OV-1/SE-54 dual column system and were compared to the packed column and single column results published earlier (6). The results are summarized in Table 25. The data indicate that both the single capillary columns $(GC)^2$ and packed column chromatographic analytical methods overestimate the concentration of PCBs in ambient air when compared to the dual column results.

PROVINCE WIDE SURVEY FOR PCB'S

The 1980 Province-wide survey for polychlorinated biphenyls was performed from June 12 to June 25, 1980. The sampling sites were identical to the 1979 survey (21) and the sampling procedure and sample processing were already described elsewhere (19).

Closer examination of the data, presented in Table 25, where a number of samples from different locations in Ontario were analysed by three different methods - a 3 m long, 2 mm I.D. column packed with Dexil 400/Anachrom Q, single fused silica capillary columns, and dual fused silica capillary columns with computerized data reduction - leads to the following conclusions:

a) The method with the dual fused silica capillary columns and computerized data reduction gives consistently the lowest results. The main reason for this reduction of the concentration of PCB's is in our opinion high resolving power of the columns and the rejection of number of gas chromatographic peaks by data reduction program, because they could not be confirmed on both columns as PCB congenors (example in Tables 20-22).

b) The results of single capillary column analysis of identical samples are in fair agreement, however, the results are in general at least an order of magnitude higher than the results of the analysis with dual capillary columns and computerized data reduction. The reason is that some gas chromatographic peaks are identified as PCB congenors, although in reality they are not PCB's at all, but unidentified impurities from the ambient air, which were not removed by the applied clean-up procedure and which have, under the given conditions, retention time close to the retention time of some of the PCB congenors, can be detected by the EC detector and reported as PCB's.

c) The results of the packed column analysis are in general at least two orders of magnitude higher than the results of the dual capillary column analysis with computerized data reduction. The main reason

for this discrepancy is insufficient efficiency of the clean-up procedure and very low resolving power of the packed column. Unidentified impurities from the ambient air, which pass through the clean-up procedure are not resolved from the PCB congenors, are detected by the EC detector and reported as PCB's.

Because of the large number of unidentified impurities which might be present in similar or even higher concentration in the "clean" air sample as the PCB congenors, it is almost impossible to guarantee at the present time that a clean-up procedure will be effective enough.

For this reason an analytical procedure for background concentration of PCB's in ambient air samples with packed column is unsuitable, unless the concentrations of PCB congenors are very high as it might be when monitoring in the close proximity of spills, PCB handling equipment, etc. But even here the clean-up procedure and analytical technique shall be carefully tested so that no impurities are identified as PCB's.

Not even high resolution gas chromatography with a single capillary column is entirely satisfactory for the monitoring of PCB's in "clean" ambient air, although because of the high resolving power it resolves significantly higher number of impurities from the PCB congenors. The data from Table 26 indicate that still a number of impurities are identified as PCB's and the results for PCB's background concentrations can be reported by as much as an order of magnitude or more higher. The high resolution gas chromatography with a single capillary column might be used for monitoring when the concentration of PCB's is very high as in proximity of spills but even here the clean-up procedure and the analytical technique shall be tested that no impurities are identified as PCB's.

High resolution gas-chromatography with two columns of different polarity is the preferable, and combined with EC detectors, the most sensitive method for PCB's in "clean" ambient air. The high resolving power of capillary columns enables not only the resolution of the majority of PCB congenors from each other but also from a high number of impurities..

As a result of the extreme stability of the fused silica capillary columns even at high termperatures the performance of the columns is stable

over long periods of time and large number of samples. As a result the reproducibility of retention times is very good and the system is suitable to computerized data reduction. Computerized data reduction with the elimination of peaks which cannot be confirmed on both columns as PCB's and correction for the influence of impurities which could not be resolved from the PCB's increases significantly the confidence to the reported data.

The data for total PCB's during the 1980 survey are summarized in Table 26. Figures 5 and 6 graphically present the location of the sampling sites and the average PCB concentrations and standard deviation for the 1979 and 1980 surveys. Detailed analytical data are presented in the addendum to this report and indicate that the average 24-hour concentrations of the total PCB's are below 1 ng/m^3.

CONCLUSION

The study confirms that the resolution of a packed column is insufficient to resolve the PCB's from interfering impurities remaining in the ambient air sample after the used clean-up procedure.

It is possible that most of the data for PCB concentrations in ambient air as indicated in previous reports (1 to 6) and literature and which have been obtained with packed columns or single capillary column are biased high due to the inefficiency of the methods unless the PCB's were completely separated from all interfering compounds.

The data from the dual capillary column analysis with the quantification method based on individual PCB's are of higher confidence level than the results from the other procedures.

The results of the 1980 province wide survey indicate that the average 24-hour concentrations of the total PCB's were below 1 ng/m^3, with the highest daily value measured at any time during the survey being 11.0 ng/m^3. These values are all below the Ontario Ministry of Environment's criterion for PCB's for 24-hour average of 150 ng/m^3.

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TABLE 1
STATIONARY PHASE AND CAPILLARY COLUMN PARAMETERS*
OF THE FUSED SILICA CAPILLARY COLUMNS

STATIONARY PHASE	DEACTIVATION	LENGTH (meters)	COLUMN RADIUS (mm I.D.)	PHASE THICKNESS (um)	MAXIMUM OPERATING TEMPERATURE (°C)	McREYNOLD'S CONSTANTS 1	2	3	4	5	6	7	Σ
METHYL SILICONE FLUID SP-2100	CARBOWAX 20M	25	0.20	0.11	280	17	57	45	67	43	-	-	
CARBOWAX 20M	CARBOWAX 20M	25	0.20	0.11	280	322	536	368	572	510	-	-	-
DIMETHYL SILICONE GUM OV-1	SILOXANE	25	0.20	0.11	350	16	55	44	65	42	32	23	222
5% PHENYL, 1% VINYL METHYL SILICONE GUM SE-54	SILOXANE	25	0.20	0.11	350	33	72	66	99	67	46	36	337

* as stated by the manufacturer

TABLE 2
HALF RETENTION INDICES FOR THE FOUR LIQUID PHASES ON THE
FUSED SILICA CAPILLARY COLUMNS

Cl- Substitution	OV-1 ASYM PARENT	OV-1 SYM PARENT	SE-54 ASYM PARENT	SE-54 SYM PARENT	SP-2100 ASYM PARENT	SP-2100 SYM PARENT	CARBOWAX 20M ASYM PARENT	CARBOWAX 20M SYM PARENT	OTHER PARENTS
0-	676	676	690	690	677	677	956	956	
2-	791	790	811	808	797	799	1103	1121	
3-	860	860	877	878	866	865	1211	1219	
4-	866	870	885	889	873	875	1228	1218	
2,3-	983	984	1005	1004	988	987	1371	1339	
2,4-	955	954	972	972	958	957	1287	1312	
2,5-	954	947	972	965	958	951	1298	1295	
2,6-	905	897	926	917	911	902	1259	1246	
3,4-	1056	1066	1076	1088	1062	1062	1530	1462	
3,5-	1013	-	1030	-	1017	-	1364	-	
2,3,4-	1166	1174	1188	1197	1170	1174	1596	-	
2,3,5-	1140	1141	1159	1162	1138	-	1544	-	2,2',3,5
2,3,6-(2,5,6)	-	1065	-	1085	-	1067	-	1471	
2,4,5-	1128	1124	1145	1140	1130	1125	1481	1500	
2,4,6-	1042	1028	1057	1042	1044	1028	1347	1395	
3,4,5-	-	-	-	-	-	-	-	-	NA
2,3,4,5-	1331	1330	1350	1349	1330	-	1750	-	
2,3,5,6-	1242	1207	1260	1222	1243	-	-	-	
2,3,4,6-	1254	1251	1272	1279	1220	-	1661	-	2,2',3,4,6
2,3,4,5,6-	1448	1414	1464	1428	1444	-	1870	-	

NA Not available

* Note the SP-2100/Carbowax 20M Dual column retention indices were only valid up to 220°C (upper temp. limit of Carbowax 20M) as the linearity of equation (1) is lost when the temperature program becomes isothermal.

TABLE 3
ORDER OF ELUTION OF AVAILABLE PCB's ON
25 METER FUSED SILICA CAPILLARY COLUMNS

	OV-1	SE-54	SP-2100	CARBOWAX 20M
1	Biphenyl	Biphenyl	Biphenyl	Biphenyl
2	2-mono	2-mono	2-mono	2-mono
3	3-mono	3-mono	3-mono	3-mono
4	4-mono	4-mono	4-mono	4-mono
5	2,2'	2,6	2,2'	2,6
6	2,6	2,2'	2,6	2,2'
7	2,5	2,5	2,5	2,4
8	2,4	2,4	2,4	2,5
9	2,3	2,3	2,3	2,4,6
10	3,5	3,5	3,5	3,5
11	2,4,6	2,4,6	2,4,6	2,3
12	3,3'	3,3'	3,3'	2,2',5
13	2,2',5	2,2',5	3,4	3,4
14	3,4	3,4	2,2',5	2,4,5
15	4,4'	4,4'	4,4'	3,3'
16	2,2',6,6'	2,2',6,6'	2,2',6,6'	4,4'
17	2,4,5	2,4,5	2,4,5	2,2',4,6
18	2,3',5	2,3',5	2,3',5	2,3',5
19	2,4',5	2,2',4,6	2,4',5	2,4',5
20	2,2',4,6	2,4',5	2,2',4,6	2,3',4,6
21	2,3,4	2,3,4	2,3,4	2,3,4
22	2,3',4'	2,3',4'	2,3',4'	2,2',6,6'
23	2,2',5,6'	2,2',5,6'	2,2',5,6	2,3',4'
24	2,2',5,5'	2,3',4,6	2,3',4,6	2,2',5,6'
25	2,3',4,6	2,2',5,5'	2,2',5,5'	2,3,5,6
26	2,2',4',5	2,2',4',5	2,2',4',5	2,4,4',6
27	2,2',4,4'	2,2',4,4'	2,2',4,4'	2,2',4,4'
28	2,4,4',6	2,4,4',6	2,4,4',6	2,2',4',5

NA - Not available at the time of analysis

TABLE 3 - Continued
ORDER OF ELUTION OF AVAILABLE PCB's ON
25 METER FUSED SILICA CAPILLARY COLUMNS

	OV-1	SE-54	SP-2100	CARBOWAX 20M
29	2,3,5,6	2,3,5,6	2,3,5,6	2,2',5,5'
30	2,2',4,6,6'	2,2',4,6,6'	2,2',4,6,6'	2,2',4,6,6'
31	2,2',3',5	2,2',3',5	2,2',3',5	2,2',4,5',6
32	2,2',3,5	2,2',3,5	NA	2,3',5,5'
33	2,3',5,5'	2,3',5,5'	2,3',5,5'	2,3',4,5',6
34	2,2',3,3'	2,2',3,3'	2,2',3,3'	2,2',4,4',6
35	2,2',4,5',6	2,2',4,5',6	2,2',4,5',6	2,2',4,4',6,6'
36	2,2',4,4',6	2,2',4,4',6	2,2',4,4',6	2,2',3',5
37	2,3,4,5	2,3,4,5	2,3,4,5	2,3,4,5
38	2,3',4',5	2,3',4',5	2,3',4',5	2,2',3,4,6
39	2,2',3,4,6	2,2',3,4,6	2,2',3,4,6	2,2',3,3'
40	2,3',4,5',6	2,3',4,5',6	2,3',4,5',6	2,3',4',5
41	2,2',4,4',6,6'	2,2',4,4',6,6'	2,2',4,4',6,6'	2,2',4,5,5'
42	2,2',4,5,5'	2,2',4,5,5'	2,2',4,5,5'	2,3',4,4',6
43	2,3',4,4',6	2,3',4,4',6	2,3',4,4',6	2,3,4,5,6
44	2,2',3,4,5'	2,3,4,5,6	2,2',3,4,5'	2,2',4,4',5',6
45	2,3,3',5,6	2,3,3',5,6	NA	2,2',3,5,5',6
46	2,3,4,4',6	2,2',3,4,5'	NA	2,2',3,4,5'
47	2,3,4,5,6	2,3,4,4',6	2,3,4,5,6	2,2',3,3',6,6'
48	2,2',3,3',6,6'	2,2',3,3',6,6'	2,2',3,3',6,6'	2,2',3,4,4',6
49	3,3',4,4'	3,3',4,4'	3,3',4,4'	2,2',3,4,5,6'
50	2,2',4,4',5',6	2,2',4,4',5',6	2,2',4,4',5',6	2,2',4,4',5,5'
51	2,2',3,5,5',6	2,2',3,5,5',6	2,2',3,5,5' 6	3,3',4,4'
52	2,2',3,4,4',6	2,2',3,4,4',6	2,2',3,4,4',6	2,2',3,4,5,5'
53	2,2',3,4,5,6'	2,2',3,4,5,6'	2,2',3,4,5,6'	2,2',3,4,4',5
54	2,2',4,4',5,5'	2,2',4,4',5,5'	2,2',4,4',5,5'	2,2',3,3',5,5',6,6'
55	2,2',3,4,5,5'	2,2',3,4,5,5'	2,2',3,4,5,5'	2,2',3,4,5,5',6

NA - Not available at the time of analysis

TABLE 3 - Continued
ORDER OF ELUTION OF AVAILABLE PCB's ON
25 METER FUSED SILICA CAPILLARY COLUMNS

	OV-1	SE-54	SP-2100	CARBOWAX 20M
56	2,2',3,4,4',5	2,2',3,4,4',5	2,2',3,4,4',5	2,2',3,3',4,5
57	2,2',3,3',4,5	2,2',3,3',4,5	2,2',3,3',4,5	2,2',3,3',4,4'
58	2,2',3,3',4,4'	2,2',3,4,4',5',6	2,2',3,3',4,4'	2,3,3',4,4',5
59	2,2',3,4,4',5',6	2,2',3,3',4,4'	NA	2,2',3,3',4,4',5,5',6,6'
60	2,2',3,4,5,5',6	2,2',3,4,5,5',6	2,2',3,4,5,5',6	2,2',3,3',4,4',5,5'
61	2,3,3',4,4',5	2,2',3,3',4,5,5',6,6'	2,3,3',4,4',5	2,2',3,3',4,4',5,5',6
62	2,2',3,3',4,4',6	2,2',3,3',5,5',6,6'	NA	
63	2,2',3,3',4,5,5',6,6'	2,2',3,3',4,4',6	NA	
64	2,2',3,3',5,5',6,6'	2,3,3',4,4',5	2,2',3,3',5,5',6,6'	
65	2,2',3,4,4',5,6,6'	2,2',3,4,4',5,6,6'	NA	
66	2,2',3,3',4,4',5,6,6'	2,2',3,3',4,4',5,6,6'	NA	
67	2,2',3,3',4,4',5,5'	2,2',3,3',4,4',5,5'	2,2',3,3',4,4',5,5'	
68	2,2',3,3',4,4',5,5',6	2,2',3,3',4,4',5,5'6	2,2',3,3',4,4',5,5',6	
69	2,2',3,3',4,4',5,5',6.6'	2,2',3,3',4,4',5,5',6,6'	2,2',3,3',4,4',5,5',6,6'	

NA - not available at the time of analysis

TABLE 4
DISTRIBUTION OF AVAILABLE PCB's IN THE
CAPILLARY COLUMNS CALIBRATION SOLUTIONS

#	SOLUTION A	SOLUTION B	SOLUTION C	SOLUTION D	SOLUTION E
1	2-mono	4-mono	2,4-	2,4,5-	2,3,5,6-
2	3-mono	2,6-	3,5-	2,3',4'-	2,2',3,3'-
3	2,2'-	2,5-	3,4-	2,3',4,6'	2,2',4,4',6-
4	2,3-	2,4,6-	4,4'-	2,2',4,6,6'-	2,2',4,4',6,6'-
5	3,3'	2,2',5-	2,4',5-	2,2',4,5',6-	2,3,4,5,6-
6	2,2',6,6'-	2,3',5-	2,2',5,6'-	2,2',3,5,6-	2,2',3,5,5',6-
7	2,2',4,6-	2,3,4-	2,2',4',5-	2,2',3,4,5'-	2,2',3,4,5,6'-
8	2,2',4,4'-	2,2',5,5'-	2,2',3,5-	2,2',3,3',4,5,5',6,6'-	2,2',3,4,4',5',6-
9	2,2',3',5-	2,4,4',6-	2,2',3,4,6-		2,2',3,3',5,5',6,6'-
10	2,3',4',5-	2,3',5,5'-	2,3',4,5',6-		
11	2,2',3,3',6,6'-	2,3,4,5-	2,3',4,5',6-		
12	2,2',4,4',5,5'-	2,2',4,5,5'-	2,3',4,4',6-		
13	2,2',3,3',4,5-	2,3,4,4',6-	2,3,3',5,6		
14	2,3,3',4,4',5-	2,2',3,4,4',6-	3,3',4,4'-		
15	2,2',3,3',4,4',5,6,6'-	2,2',3,4,5,5'-	2,2',3,4,4',5-		
16	2,2',3,3',4,4',5,5',6-	2,2',3,3',4,4'-	2,2',3,4,5,5',6-		
17		2,2',3,3',4,4',6-	2,2',3,4,4',5,6,6'-		
18			2,2',3,3',4,4',5,5'-		
19			2,2',3,3',4,4',5,5',6,6'-		

TABLE 5
BIPHENYL AND n-ALKANE RETENTION TIMES

C#	OV-1	C#	SE-54	C#	SP-2100	C#	CARBOWAX 20M
C-12	-	C-12	-	C-12	-	C-12	-
C-13	10.15	C-13	7.34	C-13	8.33	C-13	-
C-14	12.50	C-14	8.94	C-14	10.19	C-14	-
C-15	15.23	C-15	10.91	C-15	12.43	C-15	-
C-16	18.27	C-16	13.26	C-16	15.03	C-16	-
C-17	21.48	C-17	15.94	C-17	17.92	C-17	-
C-18	24.74	C-18	18.81	C-18	20.95	C-18	8.78
C-19	28.03	C-19	21.85	C-19	24.08	C-19	11.28
C-20	31.21	C-20	24.85	C-20	27.15	C-20	13.30
C-21	34.32	C-21	27.86	C-21	30.19	C-21	15.61
C-22	37.33	C-22	30.79	C-22	33.14	C-22	18.09
C-23	40.23	C-23	33.63	C-23	35.99	C-23	20.68
C-24	43.04	C-24	36.39	C-24	38.91	C-24	23.31
C-25	45.73	C-25	39.05	C-25	42.52	C-25	25.92
C-26	48.34	C-26	41.63	C-26	47.19	C-26	28.52
C-28	53.28	C-28	46.52	C-28	-	C-28	33.50
C-30	57.92	C-30	51.13	C-30	-	C-30	38.37
C-32	-	C-32	55.41	C-32	-	C-32	44.88
C-36	-	C-36	-	C-36	-	C-36	-
Biphenyl	11.37	Biphenyl	8.61	Biphenyl	9.34	Biphenyl	11.53

TABLE 6
PCB RETENTION TIME AND RETENTION INDEX RESULTS

AVAILABLE PCB ISOMERS	OV-1		SE-54		SP2100		CARBOWAX 20M	
	RETENTION TIME	RETENTION INDEX	RETENTION TIME	RETENTION INDEX	RETENTION TIME	RETENTION INDEX	RETENTION TIME	RETENTION INDEX
2-mono	14.32	1467	10.92	1500	11.86	1475	14.67	2059
3-mono	16.30	1536	12.47	1567	13.56	1544	17.27	2167
4-mono	16.49	1542	12.65	1574	13.73	1550	17.71	2185
2,2'-	17.63	1580	13.66	1615	14.74	1589	19.19	2243
2,6-	17.68	1581	13.66	1615	14.73	1588	18.48	2215
2,5-	19.19	1629	14.90	1661	16.06	1636	19.50	2255
2,4-	19.22	1630	14.90	1662	16.07	1636	19.20	2243
2,3	20.14	1659	15.77	1694	16.93	1666	21.39	2327
3,5-	21.10	1689	16.48	1719	17.77	1695	21.22	2321
2,4,6-	22.04	1718	17.25	1746	18.56	1721	20.77	2304
3,3'-	22.15	1721	17.53	1756	18.83	1730	24.28	2437
2,2',5-	22.72	1738	18.07	1774	19.30	1746	24.12	2431
4,4'-	22,75	1740	18.15	1777	19.41	1749	24.23	2435
3,4-	22.50	1732	17.82	1766	19.10	1739	25.55	2486
2,2',6,6'-	24.54	1794	19.84	1834	21.06	1803	25.72	2492
2,4,5-	24.86	1804	19.86	1835	21.18	1807	24.27	2437
2,3',5-	25.06	1810	20.17	1845	21.49	1817	26.35	2517
2,4',5-	25.51	1824	20.64	1860	21.93	1831	27.08	2545
2,2',4,6-	25.63	1828	20.59	1859	21.96	1832	27.53	2562
2,3,4-	26.11	1842	21.15	1877	22.42	1847	27.29	2553
2,3',4'-	26.18	1844	21.25	1881	22.52	1850	27.14	2547
2,2',5,6'-	26.23	1846	21.31	1882	22.60	1853	27.99	2580
2,2',5,5'-	27.83	1895	22.77	1931	24.13	1901	28.26	2590
2,3',4,6-	27.85	1895	22.62	1926	24.01	1898	27.85	2574
2,2',4',5-	28.09	1903	23.00	1939	24.35	1909	29.15	2625
2,2',4,4'-	28.26	1908	23.14	1943	24.51	1914	29.13	2625
2,4,4',6-	28.37	1911	23.16	1944	24.54	1915	29.24	2629
2,3,5,6-	28.58	1918	23.31	1949	24.69	1920	28.01	2581
2,2',4,6,6'-	28.86	1927	23.66	1960	25.01	1930	29.34	2633
2,2',3',5-	28.98	1931	23.93	1970	25.25	1938	31.21	2708
2,2',3,5-	28.98	1931	23.94	1970	25.24	1938	30.14	2665
2,3',5,5'-	29.77	1955	24.50	1988	25.94	1960	30.11	2664

TABLE 6 - Continued
PCB RETENTION TIME AND RETENTION INDEX RESULTS

AVAILABLE PCB ISOMERS	OV-1 RETENTION TIME	OV-1 RETENTION INDEX	SE-54 RETENTION TIME	SE-54 RETENTION INDEX	SP2100 RETENTION TIME	SP2100 RETENTION INDEX	CARBOWAX 20M RETENTION TIME	CARBOWAX 20M RETENTION INDEX
2,2',3,3'-	30.14	1967	25.10	2009	26.36	1974	30.46	2678
2,2',4,5',6-	30.55	1980	25.19	2012	26.62	1983	30.05	2662
2,2',4,4',6-	30.86	1990	25.49	2022	26.93	1993	31.05	2702
2,3,4,5-	31.38	2006	26.02	2039	27.38	2008	31.16	2706
2,3',4',5-	31.49	2010	26.29	2048	27.66	2017	33.42	2797
2,2',3,4,6-	31.67	2016	26.35	2050	27.73	2019	31.20	2708
2,2',3,5,6-	31.83	2021	26.47	2054	27.83	2022	32.12	2745
2,3',4,5',6-	32.26	2035	26.72	2062	28.23	2036	32.22	2749
2,2'4,4',6,6'-	32.94	2056	27.36	2083	28.87	2057	33.25	2790
2,2',4,5,5'-	33.36	2070	27.96	2104	29.40	2074	33.81	2813
2,3',4,4',6-	34.07	2093	28.63	2127	30.04	2095	33.85	2814
2,2',3,4,5'-	34.81	2117	29.51	2157	30.83	2122	34.18	2828
2,3,3',5,6-	34.82	2118	29.46	2155	38.04	2370	42.55	3128
2,3,4,4',6-	34.91	2121	29.51	2157	30.85	2122	34.50	2878
2,3,4,5,6-	35.00	2124	29.41	2153	30.83	2122	34.14	2827
2,2',3,3',6,6'-	35.19	2130	29.87	2169	31.20	2134	36.97	2942
3,3',4,4'-	35.26	2132	30.05	2175	30.87	2123	36.53	2925
2,2',4,4',5',6-	35.83	2151	30.19	2180	31.70	2151	36.77	2934
2,2',3,5,5',6-	36.40	2170	30.85	2202	32.28	2171	36.19	2910
2,2',3,4,4',6-	37.22	2198	31.72	2233	33.10	2199	37.38	2960
2,2',3,4,5,6'-	37.61	2211	32.07	2246	33.45	2211	37.64	2970
2,2',4,4',5,5'-	38.66	2247	33.04	2280	34.54	2249	38.38	3000
2,2',3,4,5,5'-	39.34	2270	33.77	2305	35.20	2272	40.25	3058
2,2',3,4,4',5-	39.68	2282	34.15	2319	31.39	2141	39.29	3028
2,2',3,3',4,5-	40.55	2312	35.06	2352	36.39	2314	42.95	3141
2,2',3,3',4,4'-	41.53	2347	36.20	2393	37.41	2349	47.24	-
2,2',3,4,4',5',6-	41.71	2354	35.95	2384	37.43	2349	40.82	3075
2,2',3,4,5,5',6-	42.29	2375	36.52	2405	35.51	2283	40.29	3059
2,3,3',4,4',5-	43.13	2404	37.61	2446	39.10	2407	48.52	
2,2',3,3',4,4',6-	43.15	2405	37.56	2444	-	-	-	-
2,2',3,3',5,5',6,6'-	43.38	2414	37.53	2443	-	-	-	-

TABLE 6 - Continued
PCB RETENTION TIME AND RETENTION INDEX RESULTS

AVAILABLE PCB ISOMERS	OV-1 RETENTION TIME	OV-1 RETENTION INDEX	SE-54 RETENTION TIME	SE-54 RETENTION INDEX	SP2100 RETENTION TIME	SP2100 RETENTION INDEX	CARBOWAX 20M RETENTION TIME	CARBOWAX 20M RETENTION INDEX
2,2',3,3',4,5,5',6,6'-	43.38	2414	37.53	2443	-	-	-	-
2,2',3,4,4',5,6,6'-	43.96	2435	38.07	2463	-	-	-	-
2,2',3,3',4,4',5,6,6'-	49.18	2635	43.21	2665	-	-	-	-
2,2',3,3',4,4',5,5'-	49.81	2661	44.02	2698	-	-	-	-
2,2',3,3',4,4',5,5',6-	52.07	2752	46.09	2783	-	-	-	-
2,2',3,3',4,4',5,5',6,6'	53.88	2827	47.78	2855	-	-	-	-
pp'-DDE	35.09	2127	29.78	2166	31.18	2134	36.76	2934
1,2,3,4-TCB	11.34	1351	8.61	1349	-	-	-	-

TABLE 7
HALF INDICES RULES FOR PREDICTING THE IDENTITIES
OF THE VARIOUS PCB CONGENORS

PSB ISOMER	OV-1		SE-54		SP-2100		CARBOWAX 20M	
	ASYM. PARENTS	SYM. PARENTS	ASYM. PARENTS	SYM. PARENTS	ASYM. PARENTS	SYM. PARENTS	ASYM. PARENTS	SYM. PARENTS
Mono-chloro								
x=1; y=0	*		*		*		*	
Di-chloro								
x=2; y=0	*		*		*		*	
x=1; y=1		*		*		*		*
Tri-chloro								
x=3; y=0	*		*		*		*	
x=2; y=1	4- 3,4-	*	4- 3,4-	*		*		*
Tetra-chloro								
x=4; y=0	*		*		*		*	
x=3; y=1		*		*		*		*
x=2; y=2	3,4-	*	3,4-	*		*	*	
Penta-chloro								
x=5; y=0	*		*		*			
x=4; y=1	*		*		*			
x=3; y=2		*		*		*		
Hexa-chloro								
x=5; y=1	*		*		*			
x=4; y=2		*		*		*		
x=3; 6=3		*		*		*		

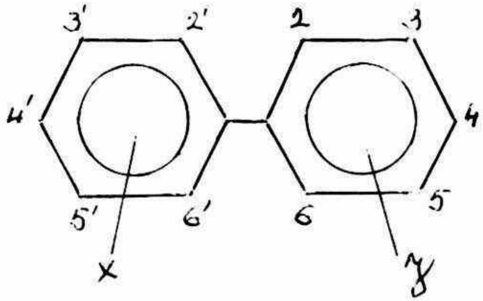
* use these types of parents to generate the retention index for the PCB whose composition is denoted by x and y.

4-; 3,4- these are exceptions to the * rule, use the parents of the column they are located in to generate the best retention index.

TABLE 7 - Continued
HALF INDICES RULES FOR PREDICTING THE IDENTITIES
OF THE VARIOUS PCB CONGENORS

PSB ISOMER	OV-1		SE-54		SP-2100		CARBOWAX 20M	
	ASYM. PARENTS	SYM. PARENTS	ASYM. PARENTS	SYM. PARENTS	ASYM. PARENTS	SYM. PARENTS	ASYM. PARENTS	SYM. PARENTS
Hepta-chloro								
x=5; y=2		*		*		*		
x=4; y=3		*		*		*		
Octa-chloro								
x=5; y=3		*		*		*		
x=4; y=4		*		*		*		
Nona-chloro								
x=5; y=4		*		*		*		
Deca-chloro								
x=5; 6=5		*		*		*		

Note:



x = no. of chlorines on one ring
y = no. of chlorines on other ring

* use these types of parents to generate the retention index for the PCB whose composition is denoted by x and y.

4-; 3,4- these are exceptions to the * rule, use the parents of the column they are located in to generate the best retention index.

TABLE 8
COMPARISON OF KNOWN AND CALCULATED RI VALUES
FOR SOME PCB's

	SP-2100			CARBOWAX 20M		
PCB ISOMER Cl-Substitution	KNOWN RI	ASYM. RI	SYM. RI	KNOWN RI	ASYM. RI	SYM. RI
2,2',5	1746	1755	1750	2431	2401	2416
2,3',5	1817	1824	1816	2517	2509	2514
2,4',5	1831	1831	1826	2545	2526	2513
2,3',4'	1850	1859	1861	2457	2633	2583
2,2',4,6	1832	1841	1827	2562	2450	2516
2,3',4,6	1898	1910	1893	2574	2558	2614
2,4,4',6	1915	1917	1903	2629	2575	2613
2,2',5,6'	1853	1869	1853	2580	2557	2541
2,2',3,4,5'	2122	2128	2125	2828	2894	-
2,2',4,5,5'	2074	2088	2076	2813	2779	2795
2,2',4,4',6	1993	2002	1985	2702	2634	2707
2,2',4,6,6'	1930	1955	1930	2633	2606	2641
2,3',4,4',6	2095	2106	2090	2814	2877	2857
2,2',4,5'	1909	1917	1908	2625	2585	2607
2,2',3,5'	1938	1947	1938	2708	2670	2634
2,3',4',5	2017	2020	2012	2797	2828	2757
2,2',4,5',6	1983	2002	1979	2662	2646	2690

TABLE 9
COMPARISON OF KNOWN AND CALCULATED RI VALUES
FOR SOME PCB's

	OV-1			SE-54		
PCB ISOMER Cl-Substitution	KNOWN RI	ASYM. RI	SYM. RI	KNOWN RI	ASYM. RI	SYM. RI
2,2',5	1739	1745	1737	1774	1783	1773
2,3',5	1810	1813	1808	1845	1849	1843
2,4',5	1824	1820	1817	1860	1856	1854
2,3',4'	1844	1847	1856	1881	1887	1895
2,2',4,6	1828	1833	1818	1859	1868	1849
2,3',4,6	1895	1902	1889	1926	1934	1920
2,4,4',6	1911	1908	1898	1944	1941	1930
2,2',3,5'	1931	1936	1931	1970	1977	1970
2,2',4,5'	1903	1908	1902	1939	1944	1937
2,2',5,6'	1846	1859	1845	1883	1897	1882
2,3',4',5	2010	2009	2014	2048	2048	2053
2,2',3,5,6	2021	2034	1997	2054	2071	2029
2,3,3',5,6	2118	2102	2067	2155	2137	2100
2,2',3,4,5'	2117	2120	2121	2157	2160	2162
2,2',4,5,5'	2070	2082	2071	2104	2117	2105
2,2',4,4',6	1990	1996	1982	2022	2029	2013
2,2',4,5',6	1980	1995	1976	2012	2028	2007
2,2',4,6,6'	1927	1947	1925	1961	1982	1959
2,3',4,4',6	2093	2098	2094	2127	2133	2129
2,2',3,3',4,5	2312	2313	2314	2352	2354	2353
2,2',3,4,4',5	2282	2285	2284	2319	2322	2314
2,2',3,4,5,5'	2270	2284	2278	2305	2322	2314
2,2',3,4,5,6'	2211	2236	2228	2246	2275	2266
2,3,3',4,4',5	2405	2386	2396	2446	2426	2437
2,2',3,4,4',6	2198	2209	2205	2233	2244	2251
2,2',3,5,5',6	2170	2196	2154	2203	2231	2187
2,2',4,4',5',6	2151	2170	2152	2180	2202	2181
2,2',3,4,5,5',6	2375	2401	2361	2405	2436	2393
2,2',3,4,4',5,6'	2354	2372	2359	2384	2406	2391
2,2',3,3',4,4',6	2405	2421	2424	2444	2460	2475
2,2',3,4,4',5,6,6'	2435	2489	2442	2463	2521	2469
2,2',3,3',4,5',6,6'	2430	2497	2458	2460	2532	2501
2,2',3,3',4,4',5,6,6'	2635	2702	2664	2665	2736	2706
2,2',3,3',4,4',5,5',6	2752	2778	2744	2783	2814	2777

TABLE 10
"AROCLORS" ON OV-1 COLUMN (25 METER)
RETENTION INDEX, RETENTION TIME AND POSSIBLE IDENTITY OF MAJOR PEAKS

RETENTION INDEX	AROCLOR (RETENTION TIME) 1016	1221	1232	1242	1248	1254	1260	IDENTITY OF PCB
1467.0	-	14.319	14.321	-				2-mono
1542.0	-	16.496	16.496	-				4-mono
1580.0	17.642	17.646	17.646	-				2,2'+2,6
1629.8	19.210	19.213	19.216	-				2,4+2,5
1647.4	19.775	19.775	19.777	19.778				2,3'
1657.8	20.109	20.109	20.110	20.113				2,3'+2,3
1692.7	21.228	-	21.231	21.234				2,2',6
1731.5	-	22.484	22.490	22.482				3,4+3,4'
1738.5	22.720	22.748	22.724	22.723	22.720			2,2',5
1742.8	22.859	-	22.859	22.862	22.862			4,4'+2,2',4
1758.3	23.365	-	23.364	23.368	-			2,3',6
1771.5	23.796	23.787	23.797	23.798	23.805			2,4',6
1810.3	25.063	-	25.063	25.067	25.064			2,3',5
1814.2	25.191	-	25.195	25.195	-			2,3',4
1826.1	25.582	25.577	25.583	25.582	25.534			2,4',5+2,2',4,6
1844.0	26.170	26.164	26.169	26.173	26.178			2,3,3'+2,3,4,+2,3',4'+2,2',5,6'
1855.2	26.539	26.542	26.538	26.543	26.537			2,2',4,6'+2,3,4
1866.4	26.905	-	26.905	26.909	26.903			no match
1879.9	27.347	-	27.348	27.351	27.345			2,2',3,6'-
1894.7	27.836	-	27.835	27.840	27.833	27.827	-	2,2',5,5'+2,3',4,6
1902.8	28.097	-	28.096	28.098	28.093	28.083	-	2,2',4',5-
1911.6	28.379	28.386	28.382	28.386	28.380	28.377	28.386	2,2',4,4'+2,4,4',6
1930.8	28.985	28.985	28.990	28.994	28.986	28.978	-	2,2',3,5'+2,2',3,5
1937.0	29.189	29.789	29.181	29.280	29.265	29.267	29.280	2,2',3,4'
1954.1	29.728	-	29.727	29.732	29.725	29.717	-	2,3'5,5'+2,2',3,4
1966.8	30.130	-	30.123	30.131	30.125	-	-	2,2',3,3'
2003.5	31.298	-	31.300	31.304	31.294	31.287	-	2,3,4,5
2010.2	31.506	-	31.505	31.508	31.500	31.495	31.501	2,3',4',5
2015.9	31.683	-	31.679	31.684	31.675	-	-	2,2',3,4,6+2,2',3,5'

TABLE 10 - Continued
"AROCLORS" ON OV-1 COLUMN (25 METER)
RETENTION INDEX, RETENTION TIME AND POSSIBLE IDENTITY OF MAJOR PEAKS

RETENTION INDEX	AROCLOR 1016	1221	1232	1242 (RETENTION TIME)	1248	1254	1260	IDENTITY OF PCB
2018.5	31.676	-	-	-	-	31.764	31.775	2,2',3,5,6+2,2',3,4'
2030.2	-	-	-	-	32.131	32.13	-	2,3,4',5',6+2,3,3',4
2045.0	-	-	32.60	32.60	32.59	32.58	-	2,2',3,3',6
2057.2	-	-	32.97	32.97	32.96	32.96	33.00	2,2',4,4',6,6'-
2069.8	-	-	33.37	33.37	33.36	33.35	33.37	2,2',4,5,5'+ 2,2',3,4,6
2079.0	-	-	33.66	33.66	33.65	33.64	-	2,2',4,4',5-
2097.5	-	-	-	34.24	#4.22	34.22	-	2,2',3,4',5+ 2,3',4,4',6
2107.5	-	-	34.53	34.53	34.52	34.52	-	2,2',3',4,5
2116.3	-	-	-	-	34.80	34.79	-	2,2',3,4,5'-
2123.7	-	-	-	35.03	35.01	35.01	-	2,3,4,5,6- + pp'-DDE
2129.8	-	-	-	-	-	35.19	35.20	2,2',3,3',4,4' + pp'-DDE
2136.5	-	-	35.40	35.41	35.39	35.39	35.40	3,3',4,4'
2154.6	-	-	35.95	35.96	35.94	35.94	-	2,2',3,3',4 + 2,2',4,4',5,',6 + 2,2,',3,5,5'6
2170.0	-	-	-	-	-	-	36.40	no match
2177.2	-	-	-	-	36.66	36.61	36.60	no match
2192.2	-	-	37.08	37.09	37.08	37.06	37.05	2,3',4,4',5 + 2,2',3,4,4',6
2210.7	-	-	-	-	37.64	37.61	37.62	2,3,3', 4',5 + 2,2',3,4,5,6'
2234.3	-	-	-	-	-	38.30	38.31	2,2',3,3',4,6
2240.0	-	-	38.46	38.46	38.45	38.46	38.49	2,3,3',4,4'-
2247.0	-	-	38.71	38.69	38.67	38.66	38.68	2,2',4,4',5,5'
2270.1	-	-	-	-	-	39.34	39.36	2,2',3,4,5,5'- + 2,2',3,3',5,6,6'-
2277.7	-	-	39.56	39.57	39.56	39.56	-	2,2',3,4,4',6,6'- + 2,2',3,4,5,5'-
2288.2	-	-	-	-	-	-	39.86	2,2',3,4,4',5'-
2296.7	-	-	-	-	40.11	40.11	40.12	no match
2303.9	-	-	-	-	-	40.32	40.32	no match
2325.9	-	-	-	-	-	-	40.93	no match
2346.7	-	-	-	-	-	41.51	41.40	2,2',3,3',4,4'+ 2,2',3,3',5,5',6+

TABLE 10 - Continued
"AROCLORS" ON OV-1 COLUMN (25 METER)
RETENTION INDEX, RETENTION TIME AND POSSIBLE IDENTITY OF MAJOR PEAKS

RETENTION INDEX	AROCLOR 1016	1221	1232	1242 (RETENTION TIME)	1248	1254	1260	IDENTITY OF PCB
2353.1	-	-	-	-	41.70	41.69	41.71	2,2',3,4,4',5',6
2374.7	-	-	-	-	-	-	42.30	2,2',3,4,4',5',6-
2386.6	-	-	-	-	-	42.63	42.64	2,2',3,3',4',5,6
2395.2	-	-	-	-	42.88	42.87	42.89	2,2',3,3',4,5,6-
2404.6	-	-	-	-	-	43.13	43.15	2,3,3',4,4',5-
2413.4	-	-	-	-	-	43.37	43.37	2,2',3,3',5,5',6,6'
2430.2	-	-	-	-	-	43.82	43.82	2,2',3,3',4,5',6,6'
2437.2	-	-	-	-	-	43.99	44.01	2,2',3,4,4'5,6,6'
2450.7	-	-	-	-	-	44.37	44.39	2,2',3,4,4',5,5'
2476.5	-	-	-	-	-	-	45.07	2,2',3,3',4,5,6,6'- +2,3,3',4,4',5,6
2506.0	-	-	-	-	-	45.85	45.86	2,2',3,3',4,4',5
2512.9	-	-	-	-	-	46.03	46.04	no match
2538.6	-	-	-	-	-	-	46.71	2,2',3,4,4',5,5',6+ 2,2',3,3',4,5,5',6
2550.9	-	-	-	-	-	-	47.03	2,2',3,3',4,5,5',6
2608.5	-	-	-	-	-	-	48.52	no match
2660.7	-	-	-	-	-	-	49.81	2,2',3,3',4,4',5,5
2778.2	-	-	-	-	-	-	52.08	no match

TABLE 11
"AROCLORS" ON SE-54 COLUMN (25 METER)
RETENTION INDEX, RETENTION TIME AND POSSIBLE IDENTITY OF MAJOR PEAKS

RETENTION INDEX	AROCLOR 1016	1221	1232	1242 (RETENTION TIME)	1248	1254	1260	IDENTITY OF PCB
1500.4	-	10.916						2-mono
1574.1	-	12.648						4-mono
1615.3	13.665	13.663						2,2' + 2,6
1661.5	14.902	14.902	14.900	14.904	-	-	-	2,4 + 2,5
1682.1	15.454	15.452	15.450	15.455	-	-	-	2,3'
1693.2	15.751	15.750	15.746	15.752	15.752	-	-	2,4' + 2,3
1730.3	16.802*	-	16.801	16.804	-	-	-	2,2',6
1756.2	-	-	17.548*	17.557	-	17.566*	-	3,3'
1766.8	-	17.851	17.850	-	-	-	-	3,4 + 3,4'
1774.4	18.072	-	18.072	18.074	18.075	-	-	2,2',5
1777.5	18.158	18.158	18.155	18.160	-	-	-	4,4' + 2,2',4
1794.2	18.642*	-	18.642	18.645*	-	-	-	2,3',6
1809.7	19.104	19.104*	19.102	19.106	19.107	-	-	2,4',6
1845.1	20.179	-	20.179	20.182	20.181*	-	-	2,3',5
1849.1	20.300	-	20.293	20.303*	-	-	-	2,3',4
1894.4	20.671	20.677	20.677	20.672	20.664	20.647*	-	2,4',5 + 2,2',4,6
1880.2	21.245	21.247	21.243	21.248	21.250	-	-	2,3,3' + 2,3,4, + 2,3',4, + 2,2',5,6
1894.4	21.675	21.673*	21.673	21.676	21.678	-	-	2,2',4,6' + 2,3,4'
1903.7	21.959	-	21.956	21.962	21.960	-	-	no match
1919.3	22.424*	-	22.420	22.425*	22.424	-	-	2,2',3,6'
1930.9	22.774	-	22.772	22.776	22.772	22.764	-	2,2',5,5' + 2,3',4,6
1938.7	23.009	-	23.009	23.012	23.008	23.000	-	2,2',4',5
1944.5	23.182	-	23.175	23.184	23.177	23.154*	-	2,2',4,4' + 2,4,4',6
1958.9	23.610	23.607	23.605	23.609	23.605	23.595	23.603	2,2',4,6,6' + 2,2',4, + 3,3',4, + 2,2',3,4,6
1970.0	23.944	-	23.942	23.946	23.942	23.933	23.937	2,2',3,5' + 2,2',3,5
1975.6	24.115	-	24.107	24.114	24.117	24.109	-	2,2',3',4-
1993.0	24.638	24.649	24.631	24.645	24.639	24.633	24.647	2,3',5,5' + 2,2',3,4
2008.6	25.104	-	25.103	25.107	25.102	-	-	2,2',3,3'
2040.0	26.050	-	26.047	26.052	26.046	26.038	-	2,3,4,5-
2048.3	26.300	-	26.297	26.302	26.295	26.288	-	2,3',4',5 + 2,2',3,4,6

* Denotes weak peak

TABLE 11 - Continued
"AROCLORS" ON SE-54 COLUMN (25 METER)
RETENTION INDEX, RETENTION TIME AND POSSIBLE IDENTITY OF MAJOR PEAKS

RETENTION INDEX	AROCLOR 1016	1221	1232	1242 (RETENTION TIME)	1248	1254	1260	IDENTITY OF PCB
2055.3	26.509	-	26.490	26.495	26.492	26.530	26.542	2,2',3,5,6 + 2,2',3,4,6 + 2,2',3,5',6
2069.2	-	-	-	26.914	26.922	26.906	26.899	2,3',4,5',6 + 2,3,3',
2078.1	-	-	27.191	-	-	-	-	2,2',3,5',6
2087.1	-	-	27.465	27.467	27.460	27.455	-	2,2',3,3',6-
2096.6	-	-	27.750*	27.756*	27.750	27.745	-	2,2',4,',6,6'
2103.8	-	-	27.962	27.966	27.959	27.954	27.962	2,2',4,5,5'-
2113.8	-	-	28.255	28.259*	28.252	28.246	-	2,2',4,4',5+ 2,2',2,4,6-
2135.4	-	-	-	-	28.882*	28.878*	-	2,2',3,4,5'
2140.1	-	-	-	29.039	29.032*	29.025	-	2,2',3,5,6,6'
2146.2	-	-	29.205*	29.207*	29.197	29.188	-	2,2',3',4,5-
2156.8	-	-	29.525*	29.528*	29.511	29.501	29.522	2,2',3,4,5'
2164.3	-	-	-	29.732*	29.730	29.725	-	pp-DDE
2166.3	-	-	29.792	-	-	-	-	2,2',3,3',6,6'-
2176.4	-	-	30.087	30.090	30.087	30.085	30.093	3,3',4,4'-
2197.6	-	-	-	30.714*	30.710	30.705	-	2,2',3,3',4-
2202.3	-	-	-	-	-	30.832	30.844	2,2',3,5,5',6 + 2,2',3,4',6,6'
2211.5	-	-	-	-	31.112*	31.104	31.109	no match
2227.7	-	-	-	-	-	-	31.564	no match
2231.0	-	-	31.660*	31.664	31.655	31.649	-	2,2',3,4,4',6+ 2,3',4,4',5
2247.2	-	-	-	-	-	32.12 *	32.13 *	2,2',3,4,5,6' + 2,3,3',4',5
2267.5	-	-	-	-	-	32.70	32.71	2,2',3,',4,6'
2280.1	-	-	33.17 *	33.18*	33.17	33.05	33.06	2,2',4,4',5,5'
2305.1	-	-	-	-	-	33.76	33.79	2,2',3,4,5,5'+ 2,2',3,3',5,6,6'
2324.0	-	-	-	-	-	34.31 *	34.26	no match
2336.6	-	-	34.67	34.67	34.65	.34.63	34.63	2,2',3,4,4',5'
2356.4	-	-	-	35.27	35.25	35.24	35.18	2,2',3,3',4,5
2373.9	-	-	-	-	-	35.65 *	35.66	no match
2384.2	-	-	-	-	-	35.92 *	35.95	2,2',3,3',5,5',6-
2393.1	-	-	36.17 *	-	36.18 *	36.18	36.19 *	2,2',3,3',4,4'

* Denotes weak peak

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TABLE 11 - Continued
"AROCLORS" ON SE-54 COLUMN (25 METER)
RETENTION INDEX, RETENTION TIME AND POSSIBLE IDENTITY OF MAJOR PEAKS

RETENTION INDEX	AROCLOR 1016	1221	1232	1242	1248	1254	1260	IDENTITY OF PCB
	(RETENTION TIME)							
2405.2	-	-	-	-	-	-	36.53	2,2',3,4,5,5',6
2411.9	-	-	-	-	36.99 *	36.99	37.00	2,2',3,4,4',5',6+ 2,2',3,3',4',5,6
2434.7	-	-	-	-	-	37.29 *	37.31	2,2',3,3',4,5,6
2443.9	-	-	37.54 *	-	37.53 *	37.61	37.55	2,3,3',4,4',5
2460.2	-	-	-	-	37.98 *	37.96 *	37.98 *	2,2',3,3',5,5',6,6'
2471.8	-	-	-	-	-	38.28 *	38.29 *	2,2',3,4,4',5,6,6'
2485.8	-	-	38.66 *	38,67 *	38.65 *	38.65	38.66	2,2',3,4,4',5,5'
2499.7	-	-	39.03	-	-	39.03	39.03 *	2,2',3,3',4,5',6,6'+ 2,2',3,4,4',5,5'
2509.6	-	-	-	-	-	-	39.29 *	2,2',3,3',4,5,5' 2,2'3,3',4,5,6,6'
2549.6	-	-	-	-	-	40.31	40.32	2,2',3,3',4,4',5-
2570.4	-	-	-	-	-	-	40.86	2,2',3,3',4,5,5',6 + 2,2',3,4,4',5,5',6
2581.7	-	-	-	-	-	-	41.15	no match
2648.6	-	-	-	-	-	-	42.81	2,2',3,3',4,5,5',6,6'
2698.2	-	-	-	-	-	-	44.02	2,2',3,3',4,4',5,5'
2783.3	-	-	-	-	-	-	46.10	2,2',3,3',4,4',5,5',6

* Denotes weak peak

TABLE 12

RELATIVE RETENTION TIMES, AVERAGE RESPONSE FACTORS, AND "AROCLOR" SOURCE OF MAJOR PCB PEAKS IN COMMERCIAL "AROCLORS"

SE-54			OV-1		
RELATIVE RETENTION TIME	AVERAGE RESPONSE FACTOR	PRESENT IN AROCLOR	RELATIVE RETENTION TIME	AVERAGE RESPONSE FACTOR	PRESENT IN AROCLOR
0.520	0.030	1016, 1232, 1221, 1242	0.565	0.031	1016, 1221, 1232, 1242
0.565	0.030	1016, 1232, 1242	0.607	0.033	1016, 1242
0.611	0.028	1232	0.653	0.030	1016, 1232, 1242, 1248
0.627	0.028	1016, 1232, 1242	0.667	0.030	1016, 1221, 1242
0.643	0.028	1016, 1221, 1232, 1248, 1254	0.680	0.030	1016, 1221, 1232, 1242, 1248
0.652	0.028	1232	0.719	0.022	1016, 1232, 1242
0.682	0.022	1016, 1232, 1242	0.757	0.023	1016, 1232, 1242, 1221, 1248
0.728	0.024	1016, 1221, 1232, 1242, 1248	0.768	0.023	1016, 1232, 1242, 1248
0.738	0.024	1016, 1232, 1242, 1248	0.781	0.023	1016, 1242, 1248
0.754	0.024	1016, 1232, 1242, 1248	0.832	0.018	1016, 1232, 1242, 1248,
0.810	0.019	1016, 1221, 1232, 1248, 1254	0.885	0.022	1248
0.854	0.020	1232	0.929	0.018	1232, 1242, 1248, 1254
0.904	0.020	1242, 1248, 1254	0.959	0.017	1242, 1248, 1254
0.928	0.019	1248, 1254, 1260	0.984	0.017	1232, 1242, 1248, 1254
0.932	0.019	1242, 1248, 1254	1.044	0.019	1221, 1232, 1248, 1254, 1260
0.949	0.019	1232, 1242, 1248, 1254	1.048	0.019	1254, 1248
0.970	0.014	1248, 1254	1.091	0.016	1254, 1260
0.980	0.014	1232, 1242, 1248, 1254	1.096	0.016	1242, 1248, 1254, 1260
1.024	0.016	1254	1.133	0.016	1254
1.031	0.016	1232, 1254	1.143	0.016	1221, 1248, 1254, 1260
1.044	0.019	1254, 1260	1.148	0.016	1254, 1260
1.053	0.019	1254	1.166	0.017	1260
1.085	0.018	1260	1.171	0.017	1221
1.097	0.018	1254, 1260	1.187	0.016	1254, 1260
1.112	0.017	1254	1.195	0.016	1221, 1254, 1260
1.151	0.018	1254	1.214	0.018	1221, 1248, 1254, 1260

TABLE 12 - Continued
RELATIVE RETENTION TIMES, AVERAGE RESPONSE FACTORS, AND "AROCLOR" SOURCE
FOR ALL MAJOR PCB PEAKS IN COMMERCIAL "AROCLORS"

SE-54

RELATIVE RETENTION TIME	AVERAGE RESPONSE FACTOR	PRESENT IN AROCLOR
1.162	0.018	1016, 1221, 1232, 1248, 1254, 1260
1.190	0.017	1260
1.196	0.017	1232, 1254, 1260
1.205	0.017	1260
1.218	0.015	1254, 1260
1.241	0.020	1254, 1260
1.251	0.020	1254, 1260
1.269	0.017	1260
1.284	0.031	1260
1.296	0.031	1254, 1260
1.308	0.031	1260
1.317	0.031	1260
1.352	0.031	1254, 1260
1.362	0.031	1260
1.369	0.031	1260
1.379	0.031	1260
1.435	0.031	1260
1.475	0.031	1260
1.484	0.031	1260
1.545	0.031	1260

OV-1

RELATIVE RETENTION TIME	AVERAGE RESPONSE FACTOR	PRESENT IN AROCLOR
1.221	0.018	1254, 1260
1.258	0.017	1221
1.264	0.017	1221, 1248, 1254, 1260
1.283	0.017	1260
1.289	0.017	1254
1.305	0.017	1260
1.309	0.017	1254, 1260
1.329	0.017	1260
1.332	0.017	1260
1.381	0.017	1260

The average response factor = $ng.ml^{-1} counts^{-1}$

Table 13. Terminal printout of the 52 congenors calibratin standard on OV-1 column.

CALIB TABLE:

CAL	RT	LEVEL	AMT	AMT/AREA	REF	NAME
1	11.384	1	7.72000E+00	1.59615E-02	+	1234-TCB
2	14.378	1	2.63700E+01	2.31367E-01		2-MONO
3	16.370	1	5.92600E+02	3.76435E+00		3-MONO
4	16.558	1	5.22000E+01	3.68425E-01		4-MONO
5	17.703	1	1.65600E+01	9.41446E-02		22'
6	19.262	1	1.34300E+01	3.17799E-02		25
7	20.205	1	8.18000E+00	3.04807E-02		23
8	21.168	1	9.03000E+00	3.53466E-02		35
9	22.110	1	2.98000E+00	1.48912E-02		246
10	22.223	1	4.07500E+01	6.56571E-02		33'
11	22.569	1	8.34000E+00	2.17504E-02		34
12	22.738	1	9.38000E+00	2.67426E-02		22'5
13	24.621	1	9.13000E+00	2.83655E-02		22'66'
14	24.919	1	4.50000E+00	1.49196E-02		245
15	25.133	1	4.29000E+00	1.26543E-02		23'5
16	25.589	1	4.74000E+00	1.71936E-02		24'5
17	25.705	1	4.73000E+00	1.62289E-02		22'46
18	26.305	1	9.65000E+00	2.37052E-02		22'56'
19	27.909	1	9.55000E+00	1.60377E-02		23'46+22'55'
20	28.167	1	4.93000E+00	1.65059E-02		22'4'5
21	28.447	1	5.00000E+00	7.97783E-03		244'6
22	28.651	1	5.96000E+00	1.46926E-02		2356
23	28.925	1	4.37000E+00	1.51103E-02		22'466'
24	29.057	1	4.70000E+00	1.36098E-02		22'3'5
25	29.837	1	4.79000E+00	1.44201E-02		23'55'
26	30.206	1	3.97000E+00	1.39957E-02		22'33'
27	30.611	1	4.93000E+00	1.57298E-02		22'45'6
28	30.930	1	4.64000E+00	1.33618E-02		22'44'6
29	31.456	1	4.71000E+00	1.74355E-02		2345
30	31.572	1	4.65000E+00	1.30011E-02		23'4'5
31	31.744	1	4.60000E+00	1.37537E-02		22'346
32	31.889	1	6.62000E+00	1.56547E-02		22'356
33	32.333	1	5.50000E+00	1.28057E-02		23'45'6
34	33.007	1	5.81000E+00	1.53134E-02		22'44'66'
35	33.435	1	4.76000E+00	1.26994E-02		22'455'
36	34.144	1	5.40000E+00	1.28950E-02		23'44'6
37	34.967	1	4.37000E+00	8.40642E-03		22'345'
38	35.163	1	2.18000E+01	1.71317E-02	+	PP-DDE
39	35.338	1	1.14100E+01	1.37384E-02		33'44'
40	35.895	1	5.35000E+00	1.43503E-02		22'44'5'6
41	36.467	1	5.36000E+00	1.76271E-02		22'355'6
42	37.291	1	5.42000E+00	1.51855E-02		22'344'6
43	37.670	1	5.66000E+00	1.26862E-02		22'3456'
44	38.746	1	5.97000E+00	1.59880E-02		22'44'55'
45	39.410	1	5.68000E+00	2.26649E-02		22'3455'
46	39.750	1	5.18000E+00	1.04844E-02		22'344'5
47	40.628	1	5.64000E+00	1.13894E-02		22'33'45
48	41.592	1	5.86000E+00	1.81829E-02		22'33'44'
49	42.362	1	4.94000E+00	1.05093E-02		22'3455'6
50	43.203	1	5.38000E+00	1.52236E-02		233'44'5
51	43.437	1	5.09000E+00	1.01314E-02		22'33'55'66'
52	43.889	1	7.50000E+00	2.02315E-02		22'33'45'66'
53	44.025	1	8.04000E+00	1.61425E-02		22'344'566'

CALIB PARAMS:
0 MULTIPLIER = 1
-1 REF WINDOW = 0.5%
-2 NON-REF WINDOW = 0.5%
-3 UNCAL RF = 0
-4 HEADING =
COLUMN#1: PCB ANALYSIS ON OV-1 CAPILLARY COLUMN
-5 SAMPLE AMT = 0

Table 14. Terminal printout of the 52 congenors calibration standard on SE-54 column.

CALIB TABLE:

CAL	RT	LEVEL	AMT	AMT/AREA	REF	NAME
1	8.643	1	7.72000E+00	1.37032E-02	*	1234-TCB
2	10.965	1	2.63700E+01	2.06741E-01		2-MONO
3	12.330	1	5.92600E+02	3.07755E+00		3-MONO
4	12.699	1	5.22000E+01	3.05966E-01		4-MONO
5	13.723	1	1.65600E+01	9.41095E-02		22'
6	14.959	1	1.34300E+01	2.76522E-02		25
7	15.840	1	5.18000E+00	2.67823E-02		23
8	16.542	1	9.03000E+00	3.21426E-02		35
9	17.320	1	2.96000E+00	1.06547E-02		246
10	17.605	1	4.07500E+01	6.20589E-02		33'
11	17.893	1	3.34000E+00	1.92706E-02		34
12	18.139	1	9.36000E+00	2.39631E-02		22'5
13	19.921	1	1.36300E+01	2.01916E-02		22'66'+245
14	20.247	1	4.29000E+00	1.12471E-02		23'5
15	20.693	1	9.47000E+00	1.55018E-02		24'5+22'46
16	21.338	1	9.65000E+00	2.32042E-02		22'56'
17	22.686	1	4.73000E+00	1.32916E-02		23'46
18	22.846	1	4.82000E+00	1.63763E-02		22'55'
19	23.062	1	4.93000E+00	1.67599E-02		22'4'5
20	23.230	1	5.00000E+00	1.38042E-02		244'6
21	23.388	1	5.96000E+00	1.54150E-02		2356
22	23.722	1	4.37000E+00	7.86170E-03		22'466'
23	24.016	1	4.70000E+00	1.22966E-02		22'3'5
24	24.572	1	4.79000E+00	1.24888E-02		23'55'
25	25.245	1	8.90000E+00	1.44276E-02		22'33' + A
26	25.568	1	4.64000E+00	1.23570E-02		22'44'6
27	26.099	1	4.71000E+00	1.37771E-02		2345
28	26.395	1	9.25000E+00	1.35482E-02		23'4'5 + B
29	26.543	1	6.62000E+00	1.60156E-02		22'356
30	26.800	1	5.50000E+00	1.30276E-02		23'45'6
31	27.442	1	5.81000E+00	1.57945E-02		22'44'66'
32	28.039	1	4.76000E+00	1.23951E-02		22'455'
33	28.703	1	5.40000E+00	1.19036E-02		23'44'6
34	29.584	1	4.37000E+00	5.30616E-03		22'345'
35	29.870	1	2.18000E+01	1.20028E-02	*	PP-DDE
36	30.133	1	1.14100E+01	1.30943E-02		33'44'
37	30.262	1	5.35000E+00	9.95966E-03		22'44'5'6
38	30.921	1	5.36000E+00	1.17743E-02		22'355'6
39	31.798	1	5.42000E+00	1.47481E-02		22'344'6
40	32.150	1	5.66000E+00	1.18139E-02		22'3456'
41	33.129	1	5.97000E+00	1.53191E-02		22'44'55'
42	33.845	1	5.68000E+00	2.06532E-02		22'3455'
43	34.235	1	5.18000E+00	1.05566E-02		22'344'5
44	35.153	1	5.64000E+00	9.22832E-03		22'33'45
45	36.270	1	5.66000E+00	1.15714E-02		22'33'44'
46	36.599	1	4.94000E+00	9.92866E-03		22'3455'6
47	37.669	1	1.04700E+01	2.65757E-02		233'44'5 + C
48	38.137	1	1.55400E+01	3.05836E-02		D + E

CALIB PARAMS:
 0 MULTIPLIER = 1
 -1 REF WINDOW = 0.5%
 -2 NON-REF WINDOW = 0.5%
 -3 UNCAL RF = 0
 -4 HEADING =
COLUMN #2: PCB ANALYSIS ON SE-54 CAPILLARY COLUMN
 -5 SAMPLE AMT = 0

Table 15. Terminal printout of the "Aroclor" synthetic standard on OV-1 column.

CALIB TABLE:

CAL	RT	LEVEL	AMT	AMT/AREA	REF	NAME
1	11.322	1	7.57000E+00	2.30615E-02	*	1234-TCB
2	14.296	1	1.46300E+02	2.46190E-01		2-MONO
3	16.280	1	1.62000E+02	1.31865E+00		3-MONO
4	16.469	1	7.18000E+01	3.60613E-01		4-MONO
5	17.412	1	[illegible]	[illegible]		[illegible]
6	19.193	1	1.72000E+01	3.24098E-02		23+24
7	19.743	1	1.45000E+01	2.69690E-02		23'
8	20.075	1	5.06000E+01	2.86223E-02		23+24'
9	21.194	1	4.50000E+00	4.09540E-02		22'6
10	22.440	1	4.00000E+00	3.39345E-02		34+34'
11	22.604	1	3.42000E+01	2.91171E-02		22'5
12	22.821	1	1.34000E+01	3.37637E-02		44'+22'4
13	23.327	1	3.70000E+00	3.14396E-02		23'6
14	23.756	1	2.53000E+01	2.90707E-02		24'6
15	24.914	1	5.00000E-01	2.51165E-02		245
16	25.024	1	5.30000E+00	2.30312E-02		23'5
17	25.150	1	3.20000E+00	2.39517E-02		23'4
18	25.540	1	4.86000E+01	1.89952E-02		22'46+24'5
19	26.120	1	2.77000E+01	2.58972E-02		22'56'+A+B+C
20	26.496	1	1.42000E+01	2.33759E-02		22'46'+234'
21	26.860	1	4.90000E+00	2.40042E-02		X
22	27.301	1	1.80000E+00	2.57422E-02		22'36'
23	27.787	1	1.63000E+01	2.20021E-02		23'46+22'55'
24	28.049	1	1.25000E+01	2.19645E-02		22'4'5
26	28.322	1	9.10000E+00	2.11520E-02		244'5+0+Y
27	28.938	1	1.60000E+01	1.99423E-02		22'3'5+D+Z
28	29.134	1	1.06000E+01	2.02591E-02		22'34'
29	29.677	1	1.58000E+01	2.19009E-02		23'55'+22'34
30	30.083	1	3.50000E+00	2.07547E-02		22'33'
31	30.753	1	4.00000E-01	1.52950E-02		22'44'6
32	30.962	1	5.00000E-01	1.90114E-02		W
33	31.246	1	8.20000E+00	1.94600E-02		2345
34	31.451	1	1.69000E+01	1.74910E-02		23'4'5
35	31.629	1	1.03000E+01	1.21707E-02		AA+E
36	31.701	1	8.50000E+00	1.87045E-02		22'356+F
37	32.079	1	2.10000E+00	1.65783E-02		23'45'6+G
38	32.542	1	5.00000E+00	1.69196E-02		22'33'6
39	32.909	1	7.00000E+00	1.85501E-02		22'44'66'+V
40	33.305	1	1.43000E+01	1.71300E-02		22'455'+H
41	33.595	1	1.11000E+01	1.76705E-02		22'44'5
42	34.026	1	4.00000E-01	1.78195E-02		23'44'6
43	34.163	1	1.00000E+00	1.47637E-02		22'34'5
44	34.473	1	5.50000E+00	1.40979E-02		22'3'45
45	34.732	1	8.40000E+00	1.30294E-02		22'345'
46	35.017	1	1.70000E+01	2.05028E-02	*	PP-DDE
47	35.340	1	3.25000E+01	2.05441E-02		33'44'
48	35.804	1	4.00000E+00	2.32794E-02		22'33'4+I+J
49	36.332	1	5.00000E-01	1.20305E-02		22'34'56'
50	36.501	1	3.20000E+00	2.10616E-02		T
51	36.716	1	2.70000E+00	1.76742E-02		U
52	37.023	1	3.27000E+01	1.67079E-02		22'344'6+K
53	37.570	1	1.40000E+00	1.22641E-02		22'3456'+L
54	38.242	1	1.70000E+00	2.91665E-02		22'33'46
55	38.397	1	1.70000E+01	1.50020E-02		233'44'+M
56	38.610	1	8.70000E+00	1.44126E-02		22'44'55'
57	39.274	1	2.10000E+00	1.65134E-02		22'3455'+N
58	39.475	1	2.10000E+00	1.89005E-02		22'344'66'+O
59	39.607	1	2.00000E+00	1.29125E-02		22'344'5'
60	40.050	1	1.51000E+01	1.60579E-02		S
61	40.256	1	1.90000E+00	1.23266E-02		R
62	40.490	1	1.60000E+00	2.08334E-02		22'33'45
63	41.455	1	5.40000E+00	1.80167E-02		22'33'44'+P
64	41.901	1	2.00000E+00	2.74567E-02		Q
65	42.569	1	8.00000E-01	2.57640E-02		22'344'5'6+6
66	42.833	1	2.00000E-01	1.20500E-02		22'33'456
67	43.070	1	2.10000E+00	1.18114E-02		233'44'5
68	43.313	1	3.00000E+00	5.57090E-02		22'33'55'66'
69	44.312	1	1.00000E+00	2.32017E-02		22'344'55'
70	45.702	1	1.80000E+00	1.77611E-02		22'33'44'5

CALIB PARAMS:
0 MULTIPLIER = 1
-1 REF WINDOW = 0.25%
-2 NON-REF WINDOW = 0.1%

OV-1

Table 16. Terminal printout of the "Aroclor" synthetic standard on SE-54 column.

CALIB TABLE:

CAL	RT	LEVEL	AMT	AMT/AREA	REF	NAME
1	8.597	1	7.60000E+00	1.94075E-02	*	1234-TCB
2	10.904	1	1.46300E+02	2.87537E-01		2-MONO
3	12.470	1	1.62000E+02	2.21219E+00		3-MONO
4	12.639	1	7.19000E+01	4.41857E-01		4-MONO
5	13.645	1	4.56000E+01	1.35923E-01		22'+26
6	14.890	1	1.72000E+01	3.40825E-02		25+24
7	15.438	1	1.45000E+01	2.99361E-02		23'
8	15.7[illegible]	1	[illegible]E+01	3.11863E-02		[illegible]
9	16.782	1	4.50000E+00	4.01242E-02		22'6
10	17.847	1	4.00000E+00	4.48593E-02		34+34'
11	18.053	1	3.42000E+01	3.45319E-02		22'5
12	18.142	1	1.84000E+01	2.57405E-02		44'+22'4
13	18.625	1	3.70000E+00	2.70342E-02		23'6
14	19.855	1	2.53000E+01	3.01049E-02		24'6
15	19.941	1	5.00000E-01	1.74791E-02		245
16	20.163	1	5.30000E+00	2.34502E-02		23'5
17	20.234	1	3.20000E+00	2.13894E-02		23'4
18	20.654	1	4.86000E+01	1.98943E-02		22'46+24'5
19	21.230	1	2.77000E+01	2.66813E-02		22'56'+A+B+C
20	21.659	1	1.42000E+01	2.23751E-02		22'46'+234'
21	21.935	1	4.90000E+00	2.31381E-02		X
22	22.397	1	1.30000E+00	2.44016E-02		22'36'
23	22.750	1	1.63000E+01	2.26668E-02		23'46+22'55'
24	22.987	1	1.25000E+01	2.23522E-02		22'4'5
25	23.157	1	9.10000E+00	1.99825E-02		244'6+0+Y
26	23.581	1	1.20000E+00	1.32216E-02		Z
27	23.918	1	1.48000E+01	1.97826E-02		22'3'5+D
28	24.096	1	1.06000E+01	2.15711E-02		22'34'
29	24.613	1	1.58000E+01	1.91899E-02		23'55'+22'34
30	25.078	1	3.50000E+00	2.07198E-02		22'33'
31	25.487	1	4.00000E-01	1.66252E-02		22'44'6
32	25.805	1	5.00000E-01	1.79305E-02		W
33	26.030	1	8.20000E+00	2.06143E-02		2345
34	26.277	1	2.03000E+01	2.06643E-02		23'4'5+AA
35	26.492	1	1.74000E+01	1.76851E-02		22'356+F+E
36	26.878	1	2.10000E+00	1.73153E-02		23'45'6+G
37	27.442	1	5.80000E+00	1.82305E-02		22'33'6
38	27.602	1	2.00000E+00	1.86549E-02		V
39	27.723	1	5.00000E+00	1.90070E-02		22'44'66'
40	27.935	1	1.50000E+01	1.86516E-02		22'455'
41	28.228	1	1.02000E+01	1.71830E-02		22'44'5+H
42	28.608	1	4.00000E-01	1.44532E-02		23'44'6
43	28.866	1	1.00000E+00	1.70652E-02		22'34'5
44	29.171	1	5.50000E+00	1.44669E-02		22'3'45
45	29.478	1	8.40000E+00	1.30150E-02		22'345'
46	29.735	1	1.97000E+01	2.45744E-02	*	PP-DDE
47	30.068	1	3.25000E+01	2.99509E-02		33'44'
48	30.440	1	8.00000E-01	1.03396E-02		I
49	30.685	1	3.20000E+00	1.33545E-02		22'33'4
50	30.806	1	1.30000E+00	1.86014E-02		22'34'56'+J
51	31.090	1	3.20000E+00	2.16391E-02		T
52	31.360	1	2.70000E+00	2.22563E-02		U
53	31.639	1	3.27000E+01	1.84984E-02		22'344'6+K
54	32.080	1	1.40000E+00	2.61426E-02		22'3456'+L
55	32.250	1	1.70000E+00	1.36530E-02		22'33'46
56	32.674	1	1.50000E+00	1.87593E-02		M
57	33.035	1	8.70000E+00	1.67170E-02		22'44'55'
58	33.153	1	1.53000E+01	1.54279E-02		233'44'
59	33.740	1	2.10000E+00	1.80247E-02		22'3455'+N
60	34.127	1	1.10000E+00	1.37648E-02		22'344'66'
61	34.239	1	1.00000E+00	1.10036E-02		O
62	34.587	1	1.79000E+01	1.73772E-02		22'344'5'+S
63	35.045	1	1.90000E+00	2.51625E-02		R
64	35.233	1	1.60000E+00	1.87060E-02		22'33'45
65	35.929	1	4.00000E-01	1.50404E-02		P
66	36.165	1	5.00000E+00	1.95604E-02		22'33'44'
67	36.308	1	1.00000E+00	2.79891E-02		Q
68	36.969	1	6.00000E-01	2.70019E-02		22'344'5'6+W
69	37.261	1	2.00000E-01	1.26760E-02		22'33'456
70	37.601	1	2.10000E+00	1.19749E-02		233'44'5
71	37.7[illegible]	1	3.00000E+00	6.95706E-03		22'33'55'66'
72	38.623	1	1.10000E+00	2.64573E-02		22'344'55'
73	40.239	1	1.30000E+00	2.63802E-02		22'33'44'5

CALIB PARAMS:

SE-54

TABLE 17
LEGEND FOR LETTER LABELS USED IN "AROCLOR STANDARD"

Letter Code	PCB
A	2,3',4'
B	2,3,3'
C	2,3,4
@	2,2',4,4'
D	2,2',3,5
Z	2,2',4,6,6'+2,2',4,5+3,3',4 + 2,2',3,4,6
E	2,2',3,5',6
F	2,2',3,4',6
G	2,3,4,4'
H	2,2',3,4,6'
I	2,2',4,4',5',6
J	2,2',3,5,5',6
K	2,3',4,4',5
L	2,3,3',4,',5
M	2,2',3,3',4,6
N	2,2',3,3',5,6,6'
O	2,2',3,4,5,5'
P	2,2',3,3',5,5',6
&	2,2',3,3',4',5,6
AA	2,2',3,4,6
BB	2,3,3',4,4',5
Q to Y	unknowns

Table 18. Program listing - Terminal 1.

```
LIST PRGM
PROGRAM:      (ANNOTATION OFF)
10   REM --PCB ANALYSIS FOR MERGED PEAKS
20   OPTION BASE 1
30   DIM O(100),P(100),T(15),U(15)
40   REM --T9=+- TOL ; TO =%TOL/100
50   T9=1
60   N6=0
70   S$=""
80   T0=0.2
90   REM COL 1 MERGED PEAKS
100  Z1=14
110  DATA 22'3'5+D+Z,1,23'4'5,2,AA+E,2
120  DATA 22'356+F,2,22'44'66'+V,3,22'455'+H,4,22'44'5,4
130  DATA 22'33'4+I+J,5,22'34'56',5,233'44'+M,6
140  DATA 22'344'66'+O,7,22'344'5',8,S,8
150  DATA 22'33'44'+P,9
160  REM COL 2 PKS
170  Z2=18
180  DATA Z,1,22'3'5+D,1,23'4'5+AA,2,22'356+F+E,2
190  DATA V,3,22'44'66',3,22'455',4,22'44'5+H,4
200  DATA I,5,22'33'4,5,22'34'56'+J,5,M,6,233'44',6
210  DATA 22'344'66',7,O,7,22'344'5'+S,8
220  DATA P,9,22'33'44',9
230  REM REPORT PK NAMES
240  Z3=9
250  DATA 22'3'5+D+Z,1,SUM-A,2,22'44'66'+V,3
260  DATA SUM-B,4,SUM-C,5,233'44'+M,6,22'344'66'+O,7
270  DATA 22'344'5'+S,8,22'33'44'+P,9
280  INPUT "FIRST PAIR (1-49) :",N7
290  INPUT "LAST  PAIR (1-49) :",N9
300  INPUT "STORE RESULTS ON TAPE (1=YES) :",N6
310  IF N6<>1 THEN 325
320  INPUT "FILE-NAME SUFFIX (0-6 CHAR) :",S$
325  INPUT "DO A RECALIB (REPLACEMENT)(1=YES):",K1
330  FOR N8=N7 TO N9
340  IF N8=0 THEN 400
350  EXECUTE X,"EDIT AUTO SEQ 6,"&VAL$(N8*2-1)
360  EXECUTE X,"EDIT AUTO SEQ 7,"&VAL$(N8*2-1)
370  EXECUTE X,"EDIT AUTO SEQ 8,"&VAL$(N8*2)
390  WAIT 2
400  GOSUB 480
410  WAIT 0.5
420  GOSUB 590
430  GOSUB 1940
440  PAGE
450  NEXT N8
460  PRINT "END OF RUN"
470  END
480  REM --CHECK IF TIME TO RECALIBRATE
490  IF(N8-10*INT(N8/10))=1 THEN 510
500  RETURN
510  EXECUTE X,"RECALIB RUN TIME"
520  PRINT "EX 510 X=";X
525  IF K1=1 THEN 546
530  EXECUTE X,"RECALIB + "
540  PRINT "EX 530 X=";X
545  GOTO 550
546  EXECUTE X," RECALIB "
547  PRINT "LINE 546 X=";X
548  K1=0
```

Table 18 - continued

```
550  EXECUTE X,"LIST CALIB"
553  WAIT 1
556  F$="CH1:"&ID$(1)&":"&S$
560  EXECUTE X," SAVE ANALYSIS """&F$&""" DEVICE# 16"
570  PRINT "ATTEMPT TO STORE: "&F$;" ERROR CODE:";X
580  RETURN
590  REM -- FINAL REPORT SUBROUTINE
600  P1=0
610  PRINT USING 620;ID$(1),HEAD$(1),HEAD$(2)
620  IMAGE @,25X,"-- MERGED ANALYSIS RESULTS --"//"SAMPLE: "20A/70A/70A/
630  PRINT USING 640
640  IMAGE "--COMPOUND--",8X,"COL 1",4X,"COL 2",6X,"AMT",2X,"COMMENTS"/
650  FOR I1=1 TO 100
660  O(I1)=0
670  P(I1)=0
680  NEXT I1
690  FOR I1=1 TO 15
700  T(I1)=0
710  U(I1)=0
720  NEXT I1
730  REM PROCESS COL 1&2 MERGED PKS
740  GOSUB 1350
750  REM --EXAMINE COL 1
760  FOR I1=1 TO #PEAKS(1)
770  C1=CAL#(I1,1)
780  IF C1=0 THEN 930
790  IF O(C1)>0 THEN 930
800  N$=NAME$(I1,1)
810  A1=AMT(I1,1)
820  A2=0
830  FOR I2=1 TO #PEAKS(2)
840  C2=CAL#(I2,2)
850  IF C2=0 THEN 910
860  IF P(C2)>0 THEN 910
870  IF N$<>NAME$(I2,2) THEN 910
880  P(C2)=1
890  A2=AMT(I2,2)
900  GOTO 920
910  NEXT I2
920  GOSUB 1100
930  NEXT I1
940  REM --GET REMAINING PKS FROM COL 2
950  FOR I2=1 TO #PEAKS(2)
960  C2=CAL#(I2,2)
970  IF C2=0 THEN 1030
980  IF P(C2)>0 THEN 1030
990  N$=NAME$(I2,2)
1000 A1=0
1010 A2=AMT(I2,2)
1020 GOSUB 1100
1030 NEXT I2
1040 GOSUB 1800
1050 REM --PRINT TOTAL
1060 PRINT USING 1070;P1
1070 IMAGE 30X,"TOTAL",1X,DDDDD.D
1080 PRINT
1090 RETURN
1100 REM -SUBR  TO COMPARE AND PRINT 2 RESULTS
1110 IMAGE 16A,2X,DDDDD.D,2X,DDDDD.D,2X,DDDDD.D,2X,12A
1120 IF A1*A2>0 THEN 1160
1130 B$="NOT PCB"
1140 A3=0
1150 GOTO 1320
```

Table 18. - continued.

```
1160 REM --CALC TOLERANCE = MAX T0,T9
1170 X=A1
1180 IF A1>A2 THEN 1200
1190 X=A2
1200 X=T0*X
1210 IF X>T9 THEN 1230
1220 X=T9
1230 REM -- COMPARE PEAKS
1240 IF ABS(A1-A2)<X THEN 1300
1250 B$="INTERFERENCE"
1260 A3=A1
1270 IF A1<A2 THEN 1290
1280 A3=A2
1290 GOTO 1320
1300 B$="CONFIRMED"
1310 A3=(A1+A2)/2
1320 PRINT USING 1110;N$,A1,A2,A3,B$
1330 P1=P1+A3
1340 RETURN
1350 REM COL 1&2 MERGED PEAK SUMMATION
1360 FOR C=1 TO 2
1370 FOR I=1 TO #PEAKS(C)
1380 C2=CAL#(I,C)
1390 IF C2=0 THEN 1770
1400 N$=NAME$(I,C)
1410 N=0
1420 IF N$<>"PP-DDE" THEN 1440
1430 N=-1
1440 IF N$<>"1234-TCB" THEN 1460
1450 N=-1
1460 IF C=2 THEN 1620
1470 REM COL 1 SEARCH
1480 IF N=-1 THEN 1560
1490 RESTORE
1500 FOR I1=1 TO Z1
1510 READ X$,X
1520 IF N$<>X$ THEN 1550
1530 N=X
1540 GOTO 1560
1550 NEXT I1
1560 IF N=0 THEN 1770
1570 O(C2)=1
1580 IF N<=0 THEN 1770
1590 T(N)=T(N)+AMT(I,C)
1600 GOTO 1770
1610 REM -- COL 2 LOOKUP
1620 IF N=-1 THEN 1730
1630 RESTORE
1640 FOR I1=1 TO Z1
1650 READ X$,X
1660 NEXT I1
1670 FOR I1=1 TO Z2
1680 READ X$,X
1690 IF N$<>X$ THEN 1720
1700 N=X
1710 GOTO 1730
1720 NEXT I1
1730 IF N=0 THEN 1770
1740 P(C2)=1
1750 IF N<=0 THEN 1770
1760 U(N)=U(N)+AMT(I,C)
1770 NEXT I
1780 NEXT C
```

Table 18 - continued.

```
1790 RETURN
1800 REM OUTPUT MERGED PEAKS
1810 RESTORE
1820 FOR I1=1 TO Z1+Z2
1830 READ X$,X
1840 NEXT I1
1850 FOR I=1 TO Z3
1860 READ X$,X
1870 A1=T(X)
1880 A2=U(X)
1890 IF A1+A2<=0 THEN 1920
1900 N$=X$
1910 GOSUB 1100
1920 NEXT I
1930 RETURN
1940 REM -- SAVE ON TAPE
1950 IF N6<>1 THEN 1990
1960 F$="CH1:"&ID$(1)&":"&S$
1970 EXECUTE X,"SAVE REPORT """&F$&""" DEVICE# 16"
1980 PRINT " ATTEMPT TO STORE: "&F$;" ERROR CODE:";X
1990 RETURN

AVAILABLE MEMORY (BYTES): 14432

PAGE
```

Table 19. Program listing - Terminal 2.

```
LIST PRGM
PROGRAM:      (ANNOTATION OFF)
10   N6=0
20   S$=""
30   REM
40   INPUT "STORE RESULTS ON TAPE (1=YES) :",N6
50   IF N6<>1 THEN 70
60   INPUT "FILE-NAME SUFFIX (0-6 CHAR) :",S$
70   INPUT "DO A RECALIB (REPLACEMENT)(1=YES):",K1
80   START
90   WAIT 2
100  Y$=SAMPLE$(1)
110  IF Y$="1" THEN 190
120  IF Y$="21" THEN 190
130  IF Y$="41" THEN 190
140  IF Y$="61" THEN 190
150  IF Y$="81" THEN 190
160  GOSUB 310
170  PAGE
180  GOTO 80
190  REM -- 1,21,41,...
200  EXECUTE X," RECALIB RUN TIME "
210  PRINT "EX 510 X=";X
220  IF K1=1 THEN 250
230  EXECUTE X," RECALIB +"
240  GOTO 280
250  EXECUTE X," RECALIB "
260  PRINT "LINE 525 X=";X
270  K1=0
280  EXECUTE X," LIST CALIB "
290  PRINT "LINE 530 X=";X
300  GOTO 160
310  REM -- SAVE ON TAPE
320  IF N6<>1 THEN 360
330  F$="CH2:"&ID$(1)&":"&S$
340  EXECUTE X,"SAVE REPORT """&F$&""" DEVICE# 16"
350  PRINT " ATTEMPT TO STORE: "&F$;" ERROR CODE:";X
360  RETURN

AVAILABLE MEMORY (BYTES): 18592

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```

Table 20 Terminal printout for sample SARI1-2 on OV-1 column.

LIST REPORT
【hp】 5880A SAMPLER INJECTION @ 16:04 JAN 16, 1981
SAMPLE # : ID CODE :
11 SARI1-2
COLUMN#1: PCB ANALYSIS ON OV-1 CAPILLARY COLUMN
ESTD

RT	EXP RT	AREA	TYPE	WIDTH	CAL	AMOUNT	NAME
0.00		BASELINE @ START RUN = 149.16					
0.00		THRESHOLD @ START RUN = 3					
0.00		PEAK WIDTH @ START RUN = 0.04					
0.00		RP: REJECT → 1E+07					
0.10		RT: INTG → OFF					
11.00		RT: INTG → ON					
11.00		RT: PEAK WIDTH → 0.02					
11.00		RT: EXTEND RT → ON					
11.00		RT: THRESHOLD → 2					
11.00		RP: REJECT → 1					
11.328	11.328	3326.87 +	BB	0.061	1	55.695	1234-TCB
16.300	16.294	26.34	VV	-----	3	58.843	3-MONO
20.097	20.096	41.00	VB	-----	8	1.136	23+24'
22.703	22.708	34.84	VV	-----	11	0.973	22'5
25.172	25.178	18.07	BP	-----	17	0.384	23'4
26.140	26.157	22.98	BB	0.108	19	0.551	22'56'+A+B+C
27.812	27.820	74.35	PV	0.103	23	1.528	23'46+22'55'
28.058	28.080	30.55	VP	-----	24	0.614	22'4'5
28.348	28.358	682.98	PV	0.158*	26	8.015	244'6+@+Y
28.956	28.975	51.72	VV	-----	27	0.935	22'3'5+D+Z
29.686	29.713	17.31	BB	0.107	29	0.349	23'55'+22'34
31.737	31.753	86.35	VV	-----	36	2.007	22'356+F
32.942	32.952	40.41	BP	0.120	39	0.662	22'44'66'+V
33.326	33.347	51.94	BV	-----	40	0.797	22'455'+H
33.606	33.638	34.22	VB	-----	41	0.532	22'44'5
34.184	34.210	34.68	BB	0.108	43	0.379	22'34'5
34.496	34.518	16.77	BP	0.092	44	0.207	22'3'45
34.757	34.779	121.71	PV	-----	45	1.336	22'345'
35.054	35.054	215.98 +	VV	-----	46	3.296	PP-DDE
35.360	35.385	73.55	VB	-----	47	1.803	33'44'
38.430	38.446	24.69	PV	0.108	55	0.323	233'44'+M
38.634	38.663	22.85	VV	-----	56	0.281	22'44'55'
39.524	39.556	221.61	VB	0.137	58	3.494	22'344'66'+O
40.077	40.104	39.32	BP	0.140	60	0.548	S
41.488	41.514	8.74	BB	-----	63	0.133	22'33'44'+P
42.595	42.628	3.62	BB	-----	65	6.967E-02	22'344'5'6+&
42.862	42.868	1.35	BB	-----	66	1.339E-02	22'33'456
43.102	43.128	1.87	BB	-----	67	1.810E-02	233'44'5
44.335	44.373	2.56	VB	-----	69	4.957E-02	22'344'55'

MULTIPLIER = 1

PAGE

Table 21 Terminal printout for sample SARI1-2
on SE-54 column.

LIST REPORT
[hp] 5880A SAMPLER INJECTION @ 16:04 JAN 16, 1981
SAMPLE # : ID CODE :
11 SARI1-2
COLUMN #2: PCB ANALYSIS ON SE-54 CAPILLARY COLUMN
ESTD

RT	EXP RT	AREA	TYPE	WIDTH	CAL	AMOUNT	NAME
0.00		BASELINE @ START RUN = 139.24					
0.00		THRESHOLD @ START RUN = 4					
0.00		PEAK WIDTH @ START RUN = 0.04					
0.10		RT: INTG → OFF					
0.10		RP: REJECT → 1E+08					
8.00		RT: PEAK WIDTH → 0.02					
8.00		RT: INTG → ON					
8.00		RT: EXTEND RT → ON					
8.00		RT: THRESHOLD → 2					
8.00		RP: REJECT → 1					
8.600	8.600	3565.86 +	BP	0.046+	1	56.699	1234-TCB
10.911	10.910	19.83	VV	-----	2	5.760	2-MONO
17.860	17.863	35.33	VV	-----	10	1.434	34+34'
18.068	18.071	22.13	VV	-----	11	0.746	22'5
19.104	19.104	29.33	BB	0.092	14	0.855	24'6
20.671	20.675	47.29	VV	-----	13	0.905	22'46+24'5
21.246	21.252	17.91	BV	-----	19	0.469	22'56'+A+B+C
22.763	22.776	50.27	BV	0.084	23	1.112	23'46+22'55'
22.990	23.013	41.46	VV	-----	24	0.899	22'4'5
23.589	23.610	235.43	BV	0.125	26	2.542	Z
23.930	23.947	40.13	VV	-----	27	0.769	22'3'5+D
24.640	24.645	522.11	BB	0.101	29	9.229	23'55'+22'34
26.286	26.306	34.48	PV	-----	34	0.682	23'4'5+AA
26.524	26.515	61.21	VB	0.098	35	1.063	22'356+F+E
27.736	27.760	15.99	VV	-----	39	0.299	22'44'66'
27.945	27.970	57.58	VV	-----	40	1.041	22'455'
28.237	28.264	21.44	VV	-----	41	0.355	22'44'5+H
29.182	29.207	14.49	VB	-----	44	0.201	22'3'45
29.493	29.517	300.63	BV	-----	45	3.202	22'345'
29.772	29.772	298.60 +	VV	-----	46	5.914	PP-DDE
30.073	30.103	170.53	VV	-----	47	4.664	33'44'
31.644	31.673	38.26	VB	-----	53	0.668	22'344'6+K
33.043	33.075	40.46	PB	0.179	57	0.661	22'44'55'
34.637	34.651	87.39	PB	0.119	62	1.487	22'344'5'+S
35.245	35.278	103.87	BB	0.131	64	1.334	22'33'45
36.347	36.356	3.87	PV	-----	67	0.117	Q

MULTIPLIER = 1

Table 22 Terminal printout of the correlated analysis of sample SARI1-2 from OV-1 and SE-54 columns.

-- MERGED ANALYSIS RESULTS --

SAMPLE: SARI1-2
COLUMN#1: PCB ANALYSIS ON OV-1 CAPILLARY COLUMN
COLUMN #2: PCB ANALYSIS ON SE-54 CAPILLARY COLUMN

--COMPOUND--	COL 1	COL 2	AMT	COMMENTS
3-MONO	58.8	0.0	0.0	NOT PCB
23+24'	1.1	0.0	0.0	NOT PCB
22'5	1.0	.7	.9	CONFIRMED
23'4	.4	0.0	0.0	NOT PCB
22'56'+A+B+C	.6	.5	.5	CONFIRMED
23'46+22'55'	1.5	1.1	1.3	CONFIRMED
22'4'5	.6	.9	.8	CONFIRMED
244'6+@+Y	8.0	0.0	0.0	NOT PCB
23'55'+22'34	.3	9.2	.3	INTERFERENCE
22'34'5	.4	0.0	0.0	NOT PCB
22'3'45	.2	.2	.2	CONFIRMED
22'345'	1.3	3.2	1.3	INTERFERENCE
33'44'	1.8	4.7	1.8	INTERFERENCE
22'44'55'	.3	.7	.5	CONFIRMED
22'344'5'6+&	.1	0.0	0.0	NOT PCB
22'33'456	0.0	0.0	0.0	NOT PCB
233'44'5	0.0	0.0	0.0	NOT PCB
22'344'55'	0.0	0.0	0.0	NOT PCB
2-MONO	0.0	5.8	0.0	NOT PCB
34+34'	0.0	1.4	0.0	NOT PCB
24'6	0.0	.9	0.0	NOT PCB
22'46+24'5	0.0	.9	0.0	NOT PCB
22'344'6+K	0.0	.7	0.0	NOT PCB
22'33'45	0.0	1.3	0.0	NOT PCB
Q	0.0	.1	0.0	NOT PCB
22'3'5+D+Z	.9	3.3	.9	INTERFERENCE
SUM-A	2.0	1.7	1.9	CONFIRMED
22'44'66'+V	.7	.3	.5	CONFIRMED
SUM-B	1.3	1.4	1.4	CONFIRMED
233'44'+M	.3	0.0	0.0	NOT PCB
22'344'66'+O	3.5	0.0	0.0	NOT PCB
22'344'5'+S	.5	1.5	1.0	CONFIRMED
22'33'44'+P	.1	0.0	0.0	NOT PCB
		TOTAL	13.3	

TABLE 23

RECOVERY EVALUATION FOR "AROCLOR" STANDARD

SAMPLE CODE	EXPECTED AMOUNT (ng/ml)	ACTUAL AMOUNT (ng/ml)	PERCENTAGE IDENTIFIED (%)
AROCLOR			
STD #1	1117.2	1044.2	93.4
STD #2	1117.2	1052.0	94.2
STD #3	1117.2	1064.8	95.3
STD #4	1117.2	1051.6	94.1
STD #5	1117.2	1072.4	96.0
STD #6	1117.2	1047.1	93.7
STD #7	1117.2	1083.5	97.0
STD #8	1117.2	983.8	88.1
STD #9	1117.2	1016.9	91.0
STD #10	1117.2	1077.3	96.4

s = 28.4 ng/ml
= 2.7%

TABLE 24

COMPARISON OF ANALYSIS OF LSB "AROCLOR" SAMPLES

	M.O.E. RESULTS OF LSB "AROCLOR" TEST SAMPLES			LSB
SAMPLE CODE	52 PCB CONGENORS STANDARD	"AROCLOR" STANDARD T #1	"AROCLOR" STANDARD T #2	ACTUAL AMOUNT
A1	1572	1565	1690	1317
A2	3535	3600	3945	3420
A3	6867	7925	7695	6850
B1	1299	1145	1555	1175
B2	4336	4025	4625	3760
B3	9713	11610	9720	8460

All results are in ng/ml.

TABLE 25
COMPARISON OF THE RESULTS BETWEEN GAS CHROMATOGRAPHY WITH PACKED COLUMN, (GC^2) AND $(GC)^2$ X 2 WITH COLUMNS OF DIFFERENT POLARITY

SAMPLE #	SAMPLE CODING	PACKED COLUMN (ng/m^3)	SINGLE CAPILLARY COLUMN (ng/m^3) SP-2100	OV-1	SE-54	DUAL COLUMN (ng/m^3) OV-1/SE-54
1	HAM-S1-I1-1	317	11 *	11	7.0	3.3
2	HAM-S1-I1-4	173	4.8*	5.2	4.1	1.4
3	HAM-SI-I1-5	52	8.7*	0.7	1.6	0.2
4	HAM-S1-I1-15	68	20 *	5.9	9.7	1.9
5	HAM-S1-I2-16	66	4.2	5.3	1.4	0.4
6	HAM-S1-I2-17	44	1.0	2.7	3.0	0.7
7	HAM-S1-I2-18	7.1	2.2	2.6	1.2	0.0
8	HAM-S1-U1-18	28	1.6*	2.5	1.0	0.02
9	HAM-S1-U2-4	128	2.4*	3.8	3.0	0.9
10	HAM-S1-U2-16	31	3.6*	2.3	1.7	0.2
11	HAM-S1-U2-18	25	4.4	2.2	1.6	0.2
12	HAM-S1-U2-24	-	74	38	32	6.0
13	KIN-S1-U1-15	3.6	4.3*	12	6.5	0.08
14	KIN-S1-U1-19	9.3	3.3*	5.2	2.7	0.3
15	LON-S1-S1-18	35	11	9.4	9.1	6.3
16	MIS-S1-U1-3	-	11 *	2.9	3.1	0.6
17	MIS-S1-U1-4	155	7.3*	3.7	2.7	0.9
18	MIS-S1-U1-17	40	5.1	3.2	2.8	0.05
19	MIS-S1-U1-18	20	1.4*	3.3	1.9	0.3
20	MIS-S1-U4-15	6.7	2.4*	3.4	3.3	0.2
21	MIS-S1-U4-16	19	1.8*	2.5	2.0	0.1
22	MIS-S1-U4-17	1.5	4.0	2.4	1.8	0.4
23	MIS-S1-U4-19	13	1.9*	2.2	1.4	0.2
24	MOO-S1-R1-4	33	2.5*	2.9	1.1	0.1
25	MOO-S1-R1-18	27	4.7*	3.1	1.7	0.3
26	NAN-S1-R1-3	96	4.9*	3.7	1.7	0.1
27	NAN-S1-R1-5	28	11 *	4.6	2.4	1.1
28	NAN-S1-R1-16	30	4.8	2.8	1.4	0.1
29	NAN-S1-R1-17	36	2.0	2.5	1.3	0.1
30	SAR-S1-I1-2	1615	6.8*	4.3	6.5	2.1
31	SAR-S1-U1-15	115	3.5	3.7	14	0.6
32	SAR-S1-U1-16	58	4.6*	6.1	4.3	0.6
33	SAR-S1-U1-17	19	3.7*	3.3	2.3	0.2
34	SAR-S1-U1-18	6.2	1.6*	3.2	1.0	0.02
35	STC-S1-R1-1	78	14 *	4.2	2.5	0.5
36	STC-S1-R1-17	15	1.9	4.7	4.2	2.0
37	SUD-S1-S1-1	66	3.9*	3.9	3.1	0.8
38	SUD-S1-S1-4	47	4.1*	3.9	2.8	0.3
39	SUD-S1-S1-17	53	1.7*	2.9	2.0	0.0
40	SUD-S1-S1-18	52	3.8*	2.3	2.1	0.0
41	TOR-S1-U1-1	28	12 *	10	10	5.4
42	TOR-S1-U1-2	238	23 *	16	15	6.9
43	TOR-SI-U1-18	6.4	4.1*	5.5	4.7	1.6
44	WIN-S1-U1-1	56	5.4*	5.8	2.3	0.7
45	WIN-S1-U1-4	97	4.5*	11	5.8	1.1
46	WIN-S1-U1-18	5.7	4.1*	2.9	1.6	0.2

TABLE 26

SUMMARY OF THE PCB DATA FOR THE 1980 PROVINCEWIDE ONTARIO SURVEY

Results are reported in ng/m^3 air

SITE*	DAYS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	Concentration Lowest	Highest	Mean ng/m^3
CAY-R1	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.12	0.01 (14)
TOR-U1	0.64	1.10	0.03	0.00	0.05	0.08	0.20	0.00	0.03	0.19	0.09	1.90	1.70	2.90	0.00	2.90	0.64 (14)
TOR-S1	0.09	0.23	0.16	0.00	0.00	0.00	0.09	0.00	0.06	0.04	0.00	0.60	0.35	1.10	0.00	1.10	0.20 (14)
OSH-U1	0.00	0.06	0.16	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.10	0.03	0.89	0.19	0.00	0.89	0.11 (14)
MIS-U1	0.05	0.00	0.20	0.05	0.09	0.00	0.08	0.03	0.00	0.00	0.07	0.53	0.53	0.24	0.00	0.53	0.13 (14)
MIS-U2	0.04	0.05	0.09	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.17	0.05	0.15	0.00	0.00	0.17	0.05 (14)
MIS-U3		0.09	0.10	0.00	0.07	0.00	0.25	0.00	0.00	0.34	0.12	0.20	0.33	0.27	0.00	0.34	0.14 (13)
MIS-U4	0.09	0.12	0.18	0.00	0.00	0.00	0.29	0.00	0.00	0.13	0.37	0.40	0.67	0.40	0.00	0.67	0.19 (14)
BUR-U1	0.05	0.29	0.46	0.04	0.00	0.09	0.06	0.00	0.00	0.14	0.00	0.01	0.08	0.25	0.00	0.46	0.10 (14)
HAM-I1	0.05	0.06	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.10	0.23	0.15	0.00	0.23	0.06 (14)
HAM-I2	0.00	0.31	0.10	0.02	0.00	0.00	0.19	0.00	0.00	0.06	0.00	0.24	0.05	0.19	0.00	0.31	0.08 (14)
HAM-U1	0.00	0.04	0.15	0.00	0.00	0.00	0.06	0.00	0.00	0.07	0.00	0.39	0.08	0.10	0.00	0.39	0.06 (14)
HAM-U2	0.00	0.12	0.03	0.00	0.00	0.00	0.05	0.00	0.00	0.01	0.00	0.12	0.22	0.00	0.00	0.22	0.04 (14)
NAN-R1	0.00	0.03	0.07	0.00	0.00	0.00	0.11	0.00	0.07	0.07	0.00	0.00	0.09	0.02	0.00	0.11	0.03 (14)
NAN-R2	0.00	11.00	0.00	0.00	0.00	0.09	0.04	0.00	0.00	0.00	0.00	0.06	0.06	0.00	0.00	11.00	0.80 (14)
THU-U1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.06	0.00	0.00	0.00	0.06	0.01 (14)
THU-R1	0.00	0.00	0.93	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00			0.00	0.93	0.08 (12)
WIN-U1	0.07	0.06	0.00	0.00	0.00	0.01	0.00	0.04		0.00	0.05	0.08	0.16	0.32	0.00	0.32	0.06 (13)
SUD-S1	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.05	0.05	0.10	0.00	0.05	0.01 (13)
SUD-R1	0.00	0.07	0.09	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.10	0.00	0.10	0.03 (14)
LON-S1	0.47	1.90	0.07	0.00	0.01	0.08	0.00	0.16	1.50	2.60	4.50	4.30	2.50	0.96	0.00	4.50	1.40 (14)
SAR-I1	0.14	0.08	0.41	0.00	0.02	0.00	0.21	0.17	0.35	0.05	0.30	1.20	0.39	0.70	0.00	1.20	0.28 (14)
SAR-U1	0.06	0.09	0.00	0.00	0.00	0.04	0.00	0.00	0.03	0.12		0.14	0.69	0.10	0.00	0.69	0.10 (13)
MOO-R1	0.00	0.07	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.12	0.00	0.14	0.03 (14)
MID-R1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	2.90	0.06	0.07	0.00	2.90	0.22 (14)

* See for the sites in Figure 6.

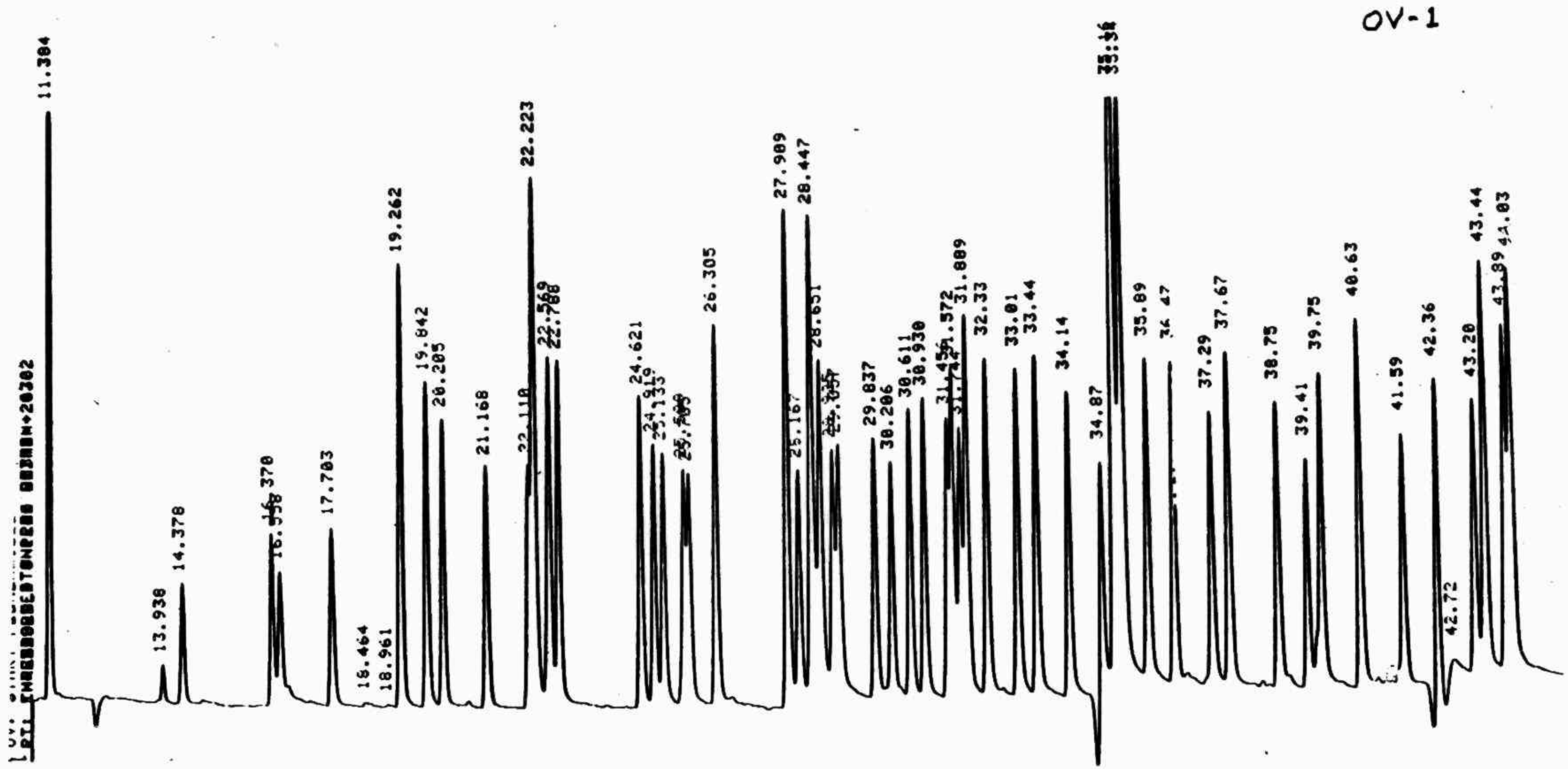


Figure 1. Calibration standard (52 congenors) on OV-1 column.

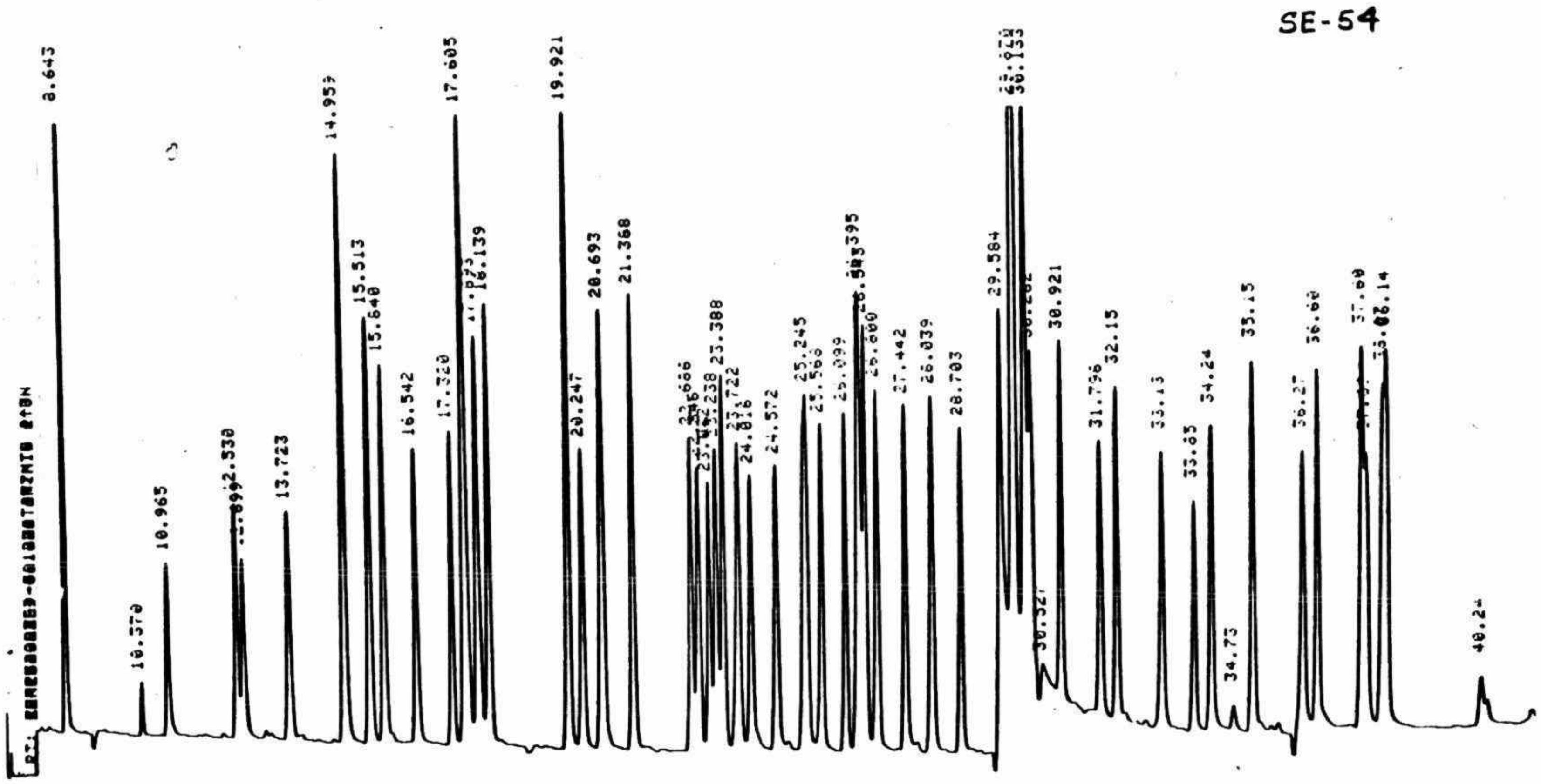


Figure 2. Calibration standard (52 congenors) on SE-54 column.

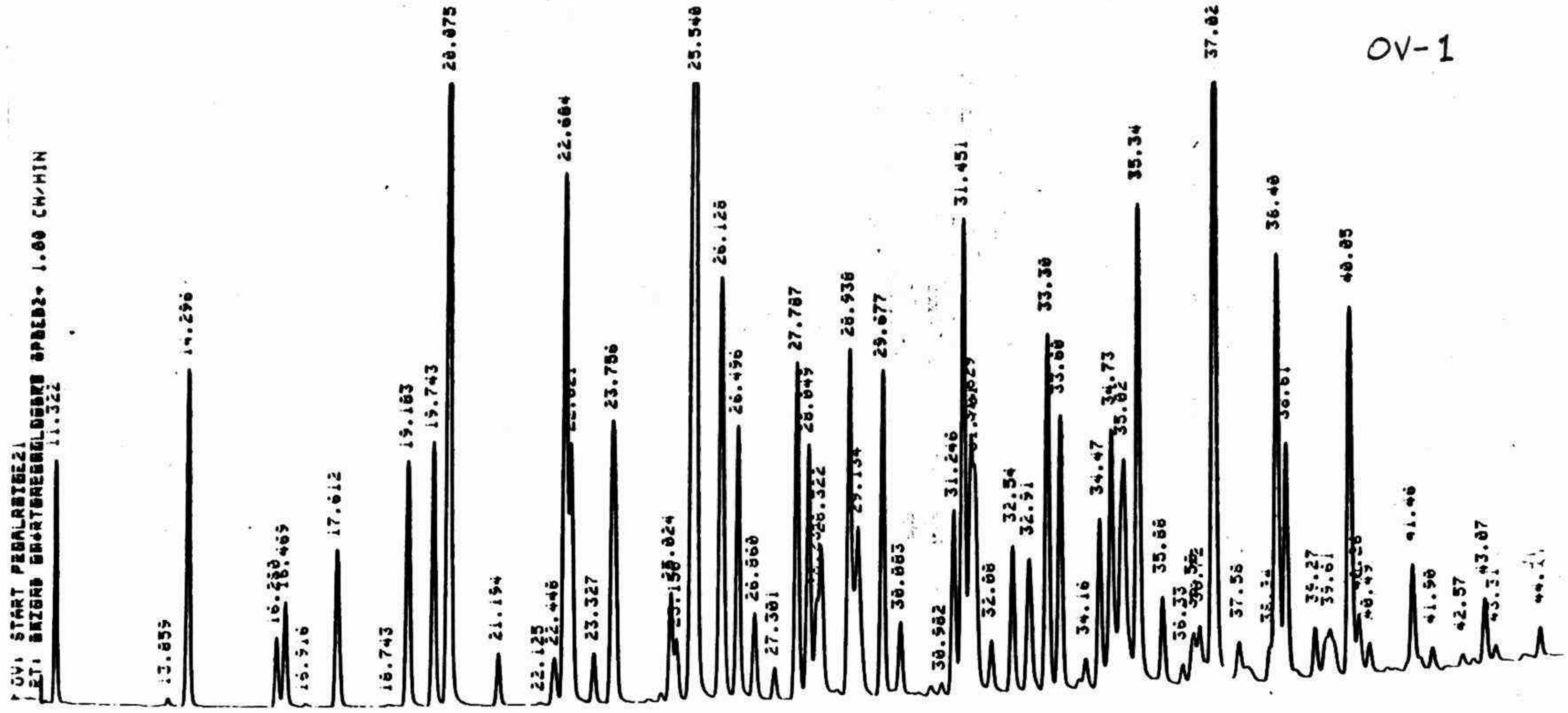


Figure 3. Synthetic "Aroclor" standard on OV-1 column.

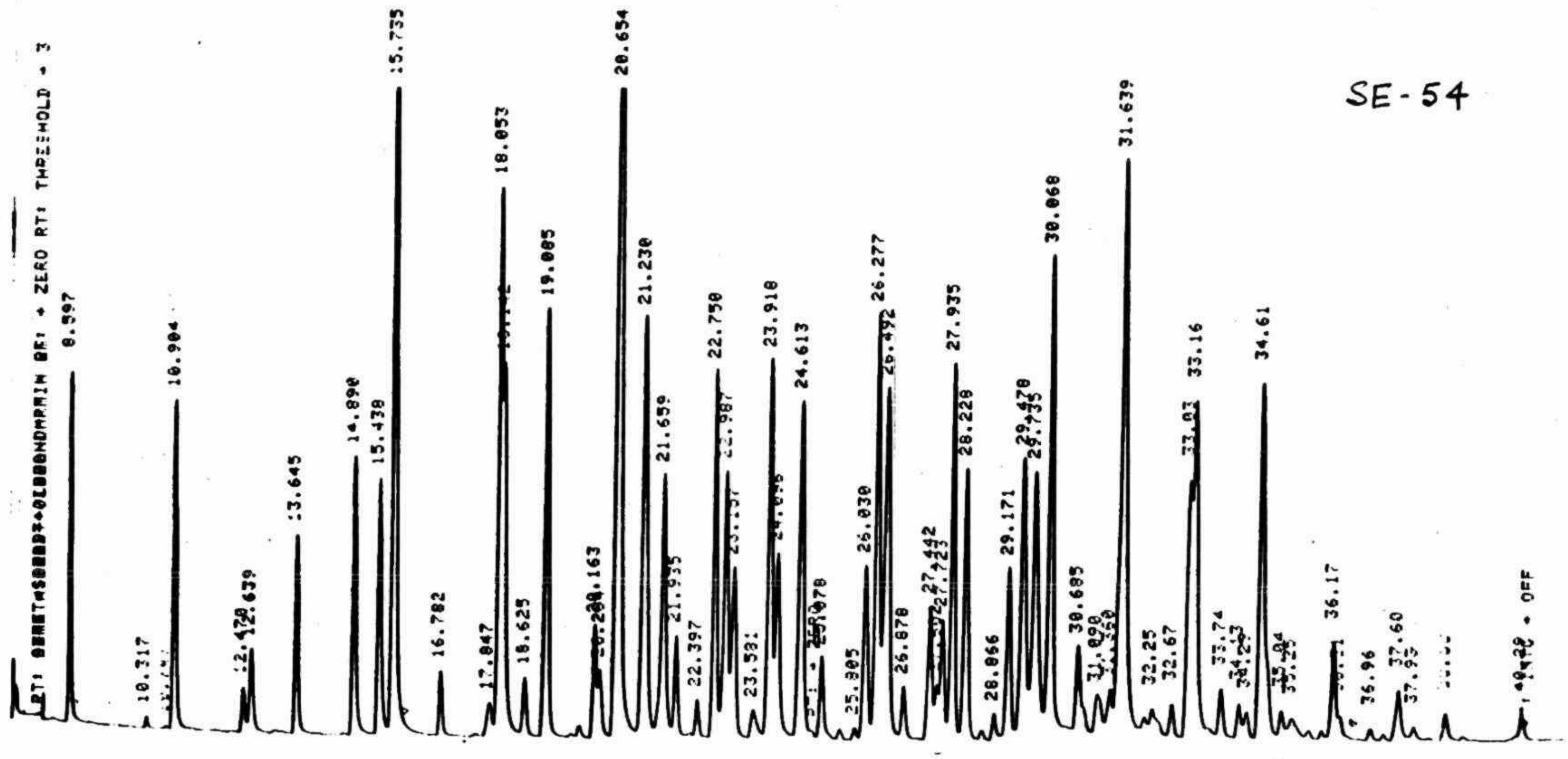


Figure 4. Synthetic "Aroclor" standard on SE-54 column.

Figure 5.

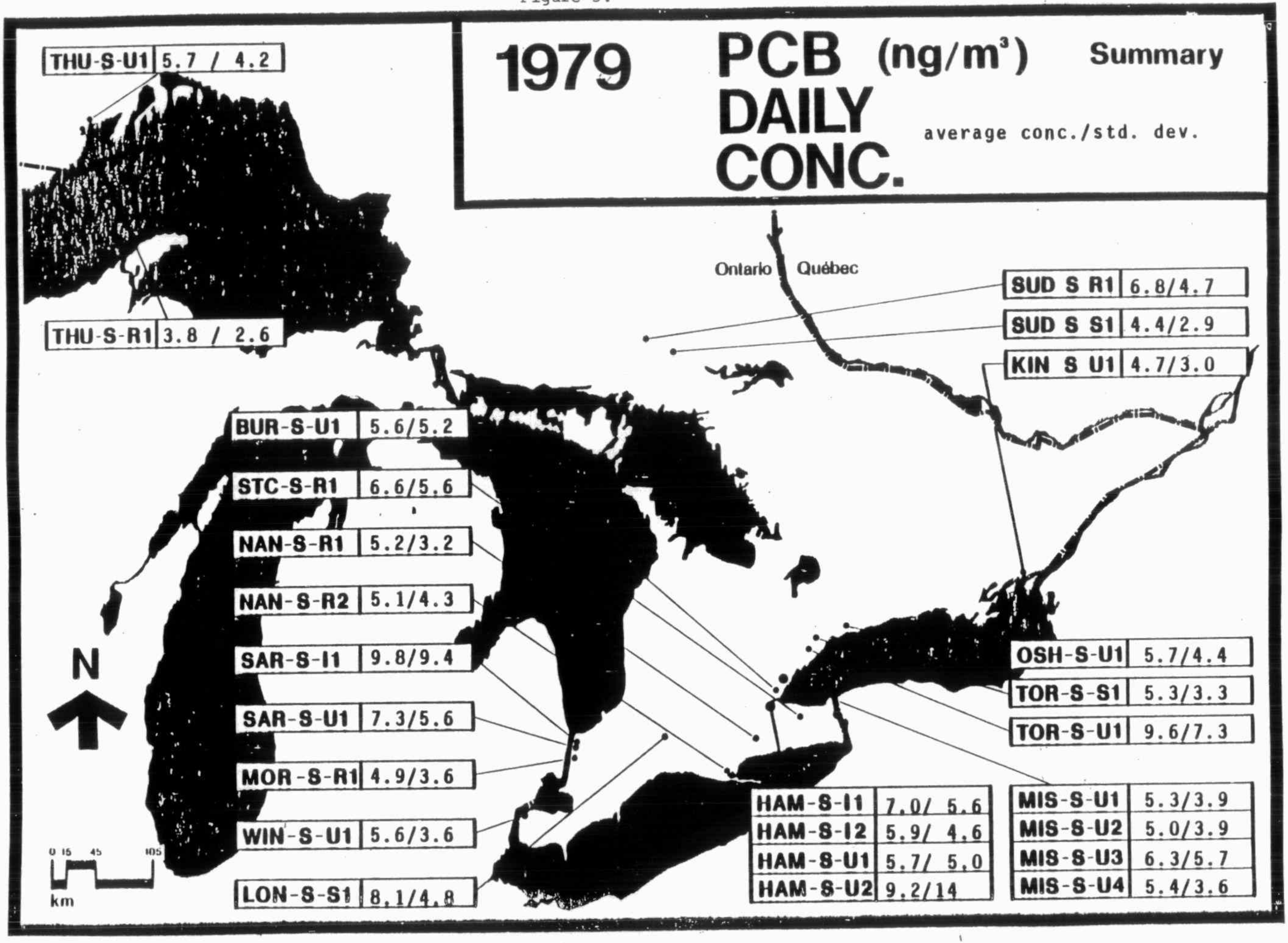
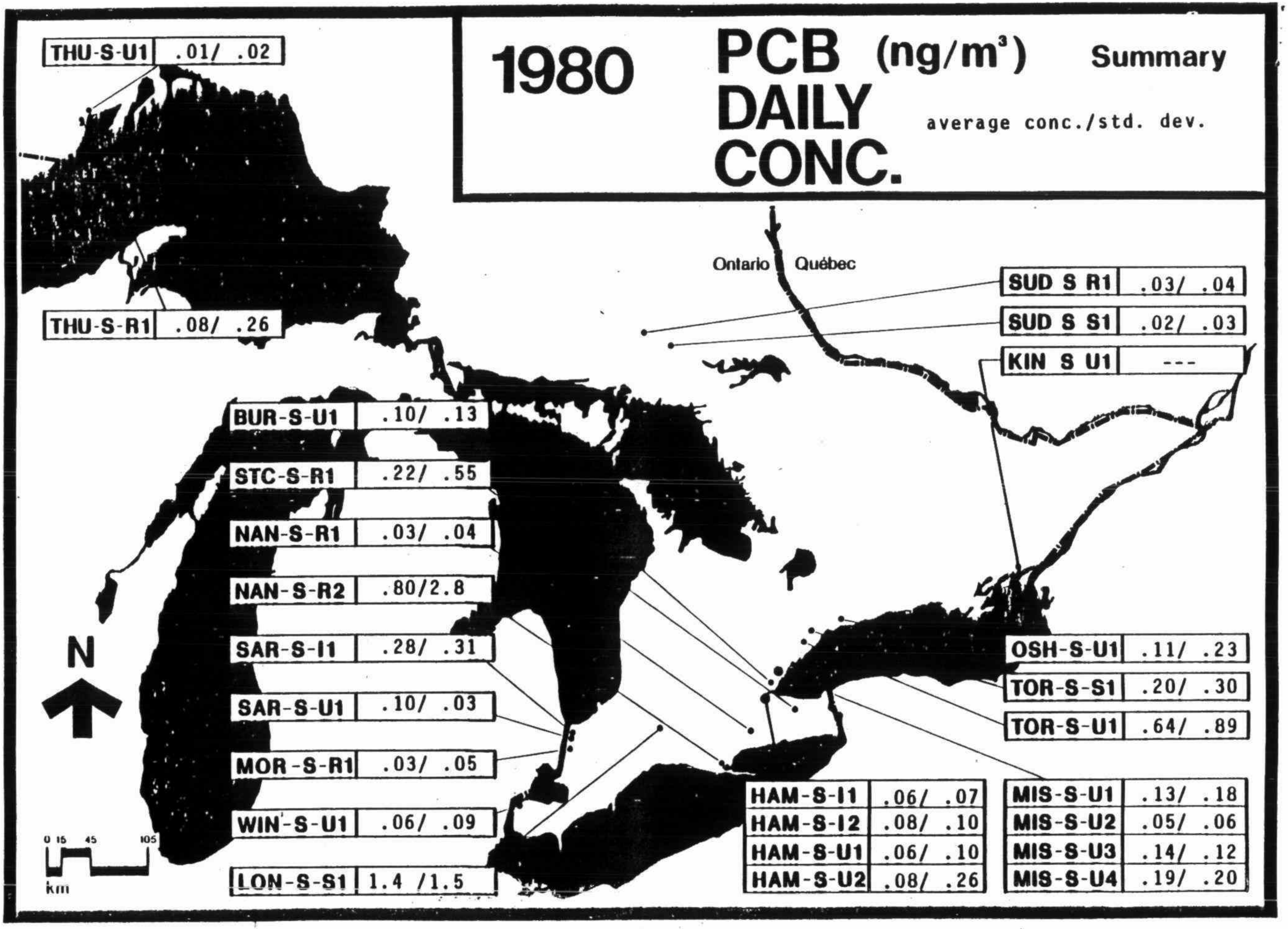

1979
PCB (ng/m³)
Summary
DAILY CONC.
average conc./std. dev.
THU-S-U1 5.7 / 4.2
THU-S-R1 3.8 / 2.6
Ontario
Québec
SUD S R1 6.8/4.7
SUD S S1 4.4/2.9
KIN S U1 4.7/3.0
BUR-S-U1 5.6/5.2
STC-S-R1 6.6/5.6
NAN-S-R1 5.2/3.2
NAN-S-R2 5.1/4.3
SAR-S-I1 9.8/9.4
SAR-S-U1 7.3/5.6
MOR-S-R1 4.9/3.6
WIN-S-U1 5.6/3.6
LON-S-S1 8.1/4.8
OSH-S-U1 5.7/4.4
TOR-S-S1 5.3/3.3
TOR-S-U1 9.6/7.3
HAM-S-I1 7.0/ 5.6
HAM-S-I2 5.9/ 4.6
HAM-S-U1 5.7/ 5.0
HAM-S-U2 9.2/14
MIS-S-U1 5.3/3.9
MIS-S-U2 5.0/3.9
MIS-S-U3 6.3/5.7
MIS-S-U4 5.4/3.6
N
0 15 45 105
km

Figure 6.


1980
PCB (ng/m³)
DAILY
CONC.
Summary
average conc./std. dev.
Ontario
Québec
THU-S-U1 .01/ .02
THU-S-R1 .08/ .26
SUD S R1 .03/ .04
SUD S S1 .02/ .03
KIN S U1 ---
BUR-S-U1 .10/ .13
STC-S-R1 .22/ .55
NAN-S-R1 .03/ .04
NAN-S-R2 .80/2.8
SAR-S-I1 .28/ .31
SAR-S-U1 .10/ .03
MOR-S-R1 .03/ .05
WIN-S-U1 .06/ .09
LON-S-S1 1.4 /1.5
OSH-S-U1 .11/ .23
TOR-S-S1 .20/ .30
TOR-S-U1 .64/ .89
HAM-S-I1 .06/ .07
HAM-S-I2 .08/ .10
HAM-S-U1 .06/ .10
HAM-S-U2 .08/ .26
MIS-S-U1 .13/ .18
MIS-S-U2 .05/ .06
MIS-S-U3 .14/ .12
MIS-S-U4 .19/ .20
N
0 15 45 105
km